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NON-AIRBORNE CONFLICTS: THE CAUSES AND EFFECTS OF RUNWAY TRANSGRESSIONS

Richard J. Tarrel

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Non-Airborne Conflicts: The Causes and Effects of Runway Transgressions

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NON-AIRBORNE CONFLICTS: THE CAUSES AND EFFECTS OF RUNWAY TRANSGRESSIONS

by

Richard J. Tarrel*

INTRODUCTION

Early on the morning of December 7, 1983, the pilot of a Boeing 727-200 received his takeoff clearance, applied power, and began rolling down runway 01 at Madrid's Barajas Airport. Visibility was less than 1000 feet. As the 727 approached the intersection of runway 01/19 and taxiways 1 through 6, the pilot saw the hazy form of a DC-9 crossing the runway ahead of him. Before his evasive maneuver could be completed, the two aircraft collided, killing 82 people.(1)**

The DC-9 had entered the runway at a point where several taxiways meet. According to some pilots, the taxiway system at Barajas is confusing and not well marked. In good weather this is not a substantial problem. When visibility is reduced, however, such conditions can lead to pilot disorientation and inadvertent runway entries.

Low visibility in fog was also significant in Anchorage, Alaska, when, two weeks after the Madrid accident, a Boeing 747F landed on a pickup truck seriously injuring the truck's driver.(2) At the same airport several days later, a DC-10 freighter attempted takeoff on the wrong runway. It struck a Piper Navajo waiting to depart at the other end.(3)

Each of these accidents resulted from a runway transgression. In 1977, it was a runway transgression that claimed the lives of 583 people at Spain's Tenerife airport. There, a 747 started its takeoff run prematurely and struck another back-taxiing on the runway in heavy fog.(4)

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** Numbered references are listed at the end of this report.

Movements on airports with operational control towers are governed by clearances. Their nature and that of clearance responses is, thus, a primary factor in causal structures underlying runway transgressions. The research described herein is motivated by a need for greater understanding of the interactions among pilots and controllers, and among air traffic controllers alone, during airport operations.

Scope

The significance of runway transgressions is as much reflected by their frequency as by their consequences. In this respect, this study attempts to uncover patterns of behavior that lead to these incidents. How often do pilots' or controllers' judgements contribute to the chain of events behind a transgression? What predisposing conditions increase the likelihood of poor judgements? Which errors, either judgemental or operational, have the propensity for snowballing into a runway transgression event?

In this study, we define runway transgression as any erroneous occupation of a runway at a controlled airport by an aircraft or other controlled vehicle. This omits occurrences at uncontrolled airports or airports where the tower is closed.

In some respects, the types of behavior and conditions associated with runway conflicts at uncontrolled fields may be similar to those at controlled facilities. Pilot behavior, weather conditions, and airport configuration can be entirely independent of the presence of a tower, thus, certain runway conflicts are just as likely at either type of airport. However, since operating practices at the two are innately dissimilar, this investigation is limited to examining problems in the controlled airport environment.

Background

Clearances are required at controlled airports for all vehicles operating within the movement areas. The Airman's Information Manual states: "Approval must be obtained prior to moving an aircraft or vehicle onto the movement area during the hours an airport traffic control tower is in

operation."[5] Movement area includes runways, taxiways, and other areas used for takeoff, landing, or taxi. Ramps and parking areas are usually excluded. Additionally, operations such as inspecting, cleaning, plowing, and construction also require tower authorization. Errors arise when any of these occur in the absence of a required clearance as well as when clearances are imprudent, conflicting, or confusing.

Tasks and responsibilities within a control tower are divided among several persons, the most significant of which are the local and ground controllers. These individuals communicate over two discrete radio frequencies with pilots and other vehicle operators. The local controller can direct and separate any aircraft that take off, land, or fly within the airport traffic area. His authority over aircraft on the airport surface usually begins when they are ready to depart, and it terminates once a landing aircraft has left the runway. The ground controller, by current practice, is responsible for all vehicle movements <u>prior</u> to takeoff and <u>after</u> landing. Thus, the division of labor between these positions is primarily predicated upon the phase of operation and not necessarily the physical location of a vehicle: Local controllers handle takeoffs and landings, while ground controllers handle taxiing. Thus, the ground controller is also responsible for clearing taxiing aircraft and vehicles across runways. These geographically overlapping controller authorities can create the opportunity for errors that lead to runway conflicts.

In 1978, through the use of ASRS data, C. E. Billings and D. B. O'Hara authored "Human Factors Associated with Runway Incursions".[6] Their report drew three major conclusions. First, "Incursions by aircraft on the runways of controlled airports represent a significant safety problem." Implied in this conclusion is the finding that many runway transgressions result in conflicts between aircraft or other vehicles. Second, "An important factor in both pilot-initiated and controller-initiated runway transgressions is the failure of information transfer among the relevant system participants." Third, "Taxiing aircraft are a major contributor to these occurrences." The report also concluded that ASRS data indicated the most effective single point of attack on the problem would focus on aircraft in the taxi phase.

The study reported herein completes a second effort toward using NASA's Aviation Safety Reporting System (ASRS) to examine runway transgressions. It responds to a specific request[7] by the Federal Aviation Administration at a time when the National Airspace and Air Traffic Control Systems are undergoing fundamental re-evaluations. Several other factors also motivate this re-examination: First, recent runway collisions have heightened public awareness of a potential problem. Second, the 1981 labor strike and subsequent dismissal of most air traffic controllers have led to a gradual rebuilding of the ATC system. By the FAA's own estimate, this process is still not complete. Entities within and without the government have been carefully scrutinizing the performance of the newly-staffed system, and, as traffic volume returns to its pre-strike level, runway transgressions may act as an indicator of controller effectiveness. Finally, ATC procedural changes instituted since ASRS's last look at this topic have now had time to make their presence felt, ASRS having received some 24,000 reports in the five years since the first study.

Role of ASRS Data

ASRS reports are submitted voluntarily. They describe only occurrences within the aviation system that reporters believe are important to safety and that they choose to communicate. Prerequisite to this, reporters must be able to perceive the safety aspect of the events they report -- a requirement more relevant than some may find obvious. Knowledge of ASRS is by no means universal, particularly within some factions of the general aviation community. Consequently, ASRS data probably underrepresent the problems encountered by those groups.

The greatest strength of ASRS information lies in its descriptions of human behavior within the aviation system. Prior to its inception, available data on patterns of behavior and response were inherently incomplete. Many aviation accidents result in the deaths of the participants, and no attempt at accident reconstruction can elicit the entire patterns of thought, perception, and judgement that precipitate such events. Even in accidents where the principals survive, it is difficult, in an adversarial environment, to

obtain full information regarding what transpired and why. Through ASRS, however, reporters may tell as much or as little as they choose, knowing that their reports are confidential and anonymous.

APPROACH

In the course of ASRS's existence, several terms have been used to label runway transgression occurrences. Among these are: "runway incursion", "unauthorized landing", "wrong runway takeoff", "occupied runway takeoff", "uncoordinated runway crossing", and "uncoordinated landing". A search strategy using these terms and others yielded 1210 reports of potential runway transgressions. This was taken to be the population dataset of all such events reported to ASRS since May 1, 1978. The search was conducted in January 1984 when the database contained 23,291 reports. After detailed analysis of a random sample of the transgression set, a 4.2 percent false positive rate was found, meaning that this fraction of the 1210 reports was estimated to be irrelevant to this study and discarded.

Methodology

The size of the population dataset precluded an individual analysis of every report. To trim down this wealth of data, a one-out-of-three sample was used. This brought to approximately four hundred the total number of reports evaluated in detail.

Although most of the coded information in ASRS records is derived directly from facts provided by the reporters, labelling the causal factors falls to the judgement of ASRS analysts. Such labels are applied without the benefit of knowing to what research a particular report will be applied. Studying a topic such as runway transgressions thus requires an independent reassessment of the sample reports. This ensures a consistency of approach not otherwise available and allows for the assigning of pertinent factors that may be applicable only to this particular topic.

The analysis process used herein is diagrammed in Figure 1. For each type of occurrence a two directional assessment is performed. First, the event causal structure is described in terms of enabling and associated factors. Next, the consequences are judged as well as any recovery actions initiated. This presumes that the causes and consequences of an incident can be related through the type of occurrence. By the same token, the degree of recovery is assumed to have a logical relationship to the severity of the consequence.

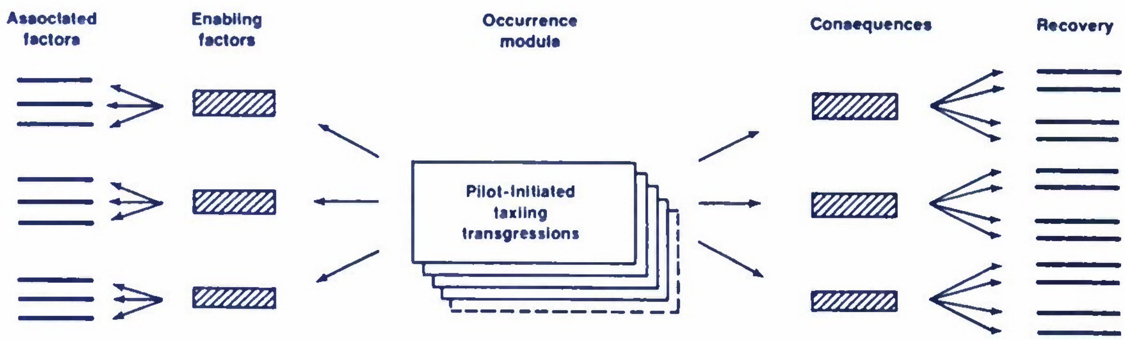

FIGURE 1. TOPICAL ANALYSIS PROCESS

Sample Dataset Categorization

The recoding process for the sample dataset sought to describe each incident through six characteristics elemental to the topical analysis: The most general is the Type of Occurrence. Enhancing this is the Enabling Actor which identifies the primary source of fault. Causal structure is then described by Enabling and Associated Factors. The Consequence entry essentially describes whether a conflict arose and what its severity was. Finally, Recovery, if it occurred, is described in terms of the players who initiated it and the actions they took.

Type of occurrence. - This classification is a general description of the character of an incident. As was evident prior to the topical analysis, several predictable situations can lead to a runway transgression. Thus,

terms such as "unauthorized runway crossing", "wrong runway takeoff", and "unauthorized landing" all refer to general categories of runway transgressions.

Appendix A shows the authorized entries for Type of Occurrence. After reviewing a significant portion of the sample reports, it was found that ground vehicle transgressions usually arose out of behaviors quite similar to those of aircraft transgressions. Although a number of reports involving ground vehicles appeared in the sample set, efforts to code them separately were abandoned when it became apparent that they did not warrant unique classification.

Enabling actor. - This is the participant who is adjudged as bearing the primary responsibility for the transgression. The list of authorized entries also appears in Appendix A. The Enabling Actor is the individual who had the last reasonable chance to prevent the occurrence. Often, the first error precipitating an incident will coincide with the last reasonable chance at prevention. This usually arises when the chain of events has only one definable link.

During the initial reading of the sample report set it became evident that apportioning responsibility for an incident was not always straightforward. There appeared several examples of reports where a participant, seeing the runway occupied while an aircraft was approaching, took no action to avert the situation when he or she was perfectly capable, and doing so would be considered good operating practice. In such cases it may be plausible to assign some responsibility to that individual. Witness the following controller-submitted report:

> " . . . Small aircraft A called on frequency and was cleared to land. Small transport B called ready at 12L approach end and was told to taxi into position and hold with an aircraft on landing roll. During this time, approach called on hot line for voice coordination about small aircraft C...for landing on runway 12R . . . As I returned my attention to approach end of 12L, I observed small aircraft A landing approximately 1000 feet down 12L, over small transport B . . ."

This incident, which occurred during daylight hours in visual meteorological conditions (VMC), was obviously precipitated by the local controller's error. His attention was diverted from the runway and he failed to clear the small transport for takeoff in a timely manner. Aircraft A, however, was in excellent position to see that the runway was occupied, yet failed to question the situation or execute a go-around. Instead, the pilot chose to land over the top of the transport, putting it behind him and blinding himself to its movements. Had the pilot of A gone around, as would be consistent with good operating practice, this runway conflict would not have occurred. Barring extenuating circumstances, A's failure to go around is virtually inexcusable. As such, both the pilot and the controller were coded as Enabling Actors.

Associated and enabling factors. - These classifications address the causal structure of a runway transgression. The allowable entries for both categories appear in Appendix A. Differentiating between a causal factor that is enabling versus one that is associated is an analytical judgement. In this study, a factor was considered enabling only if it described a link in the chain of events culminating in a transgression. When this determination was not possible, when factors merely added to the probability of an operational error, or when they contributed only to the severity of an incident, they were labelled as associated. To be considered enabling, a particular factor had to evoke a negative response to the question: Had the factor not been present, would this incident probably still have occurred?

Consequences. - Aircraft conflicts are a consistent motivation for ASRS reports. Usually, runway transgressions compromise safety only if other aircraft or vehicles are present. Thus, the Consequence classification denotes whether a conflict occurred and, if so, its severity.

ASRS codes conflicts in three categories. Those resulting in near collisions are termed "critical". They require that a pilot have taken emergency evasive action or would have had there been time. If a collision hazard was present but circumstances weren't severe enough to be termed critical, then the conflict is categorized as "hazardous". Finally, conflicts

that pose no threat of collision, but are considered to be separation anomalies, are termed "possible".

Evaluating conflict severity is a subjective process. That which constitutes an imminent collision hazard to one reporter may not seem as severe to another and, although objective standards can provide guidance, they do not directly address the real issue. Rating conflicts by severity is actually an attempt at comparing the time available for perception and recognition of a dangerous situation, with the pilot's capability to decide upon and execute avoidance actions. If a collision is actually imminent, it will occur unless a pilot's psychological and physiological process time is less than the closure time determined by the physics of vehicle motion and maneuverability.

Recovery actions. - Since it is likely that human error will never approach insignificance within the air traffic system, participants must be capable of recognizing and compensating for the mistakes of others. With automobiles, this is known as defensive driving; evasive action in aviation usually connotes an extreme form. The Recovery classifications describe this process when present in runway transgression reports. Two aspects of information were recorded: The Recovery Initiator is the person who initially recognized that a problem existed. This individual need not have taken action toward recovery: sometimes the person first recognizing the problem is incapable of acting or lacks the time to act. Actual attempts at recovery are described under "Recovery Actions". This classifies avoidance maneuvers into general categories consistent with types most often described by ASRS reporters. Appendix A lists the various entries.

FINDINGS

Population and Sample Factor Comparisons

The ASRS database yielded incidents spanning a 65-month period, from May 1978 through September 1983. On average, approximately 18 reports per month alluded to runway transgressions. This takes into account the estimated 4.2

percent rate of false positives observed in the sample set. Although deducting the false positives reduces the population size from 1210 to 1159, it must also be noted that some reports allude to more than one incident. In the one-out-of-three sample, 386 of 403 total reports referenced 396 runway transgressions. It is likely then, that the population encompasses about 1189 transgression incidents or 2.6 percent more than the number of applicable reports. The following analyses assume the number of incidents to be approximately 1.5 to 2.0 percent less than the total number of reports in the set.

Descriptive factors. - Table 1 depicts fractional breakdowns of various descriptive factors coded in ASRS reports. Values are shown for the population, sample, and total ASRS database. In all cases, it can be seen that the sample and population data are well correlated.

The first data group tallies types of air traffic control facilities. Air traffic control towers appear more frequently in the two groups involving runway transgressions than in the entire database. This is to be expected as a result of the geographical restriction inherent in the definition of a runway transgression.

ASRS analysts, as part of the routine coding process, identify that element of the aviation system which they judge as the primary problem for each incident. On the presumption that the topical analysis would fall largely in agreement with this determination, a correlation that did indeed hold, it is useful to examine the breakdown of primary problem entries. The second data group in Table 1 shows the primary problem distribution for the three sets of interest. Again, the population and sample report sets correspond well. When these are compared with the distribution of problems within the database as a whole, it is interesting to note that flight crew problems are over-represented by approximately 12 percent in runway transgression reports while ATC errors run about 8 percent less than the norm. Airport problems are cited twice as often in transgression reports while all other problem categories appear noticeably less frequently than the database average.

TABLE 1. DESCRIPTIVE FACTOR COMPARISONS

Factors	Population		Sample		Total Database (5/78-9/83)	
	No. of Rpts	Percent	No. of Rpts	Percent	No. of Rpts	Percent
1. Controlling Facility						
Tower	1,068	88.3	360	89.3	6,209	26.3
Tracon	81	6.7	26	6.5	8,225	34.9
Center	3	0.2	1	0.2	1,624	6.9
Other	58	4.8	16	4.0	7,512	31.9
2. Primary Problem						
Flight Crew Error	766	63.3	247	61.3	11,789	50.0
ATC Human Error	331	27.4	118	29.3	8,475	36.0
Arpt Condition, Layout, Procedures	80	6.6	25	6.2	722	3.1
Aircraft Equipment	13	1.1	5	1.2	879	3.7
Other (including weather related)	15	1.2	5	1.2	542	2.3
Navigation/Comm Equipment	2	0.2	1	0.2	819	3.5
Publications	3	0.2	2	0.5	343	1.5
Other						
3. Day of Week						
Sunday	159	13.1	49	12.2	2,602	11.0
Monday	148	12.2	46	11.4	2,975	12.6
Tuesday	167	13.8	54	13.4	3,256	13.8
Wednesday	191	15.8	51	12.7	3,771	16.0
Thursday	184	15.2	80	19.9	3,539	15.0
Friday	190	15.7	64	15.9	3,677	15.8
Saturday	138	11.4	49	12.2	2,343	9.9
Unknown	25	2.1	6	1.5	570	2.4
4. Quarter of Day						
1 (0000-0600)	27	2.2	7	1.7	428	1.8
2 (0600-1200)	374	30.9	115	28.5	7,200	30.5
3 (1200-1800)	531	43.9	190	47.1	10,350	43.9
4 (1800-2400)	242	20.0	81	20.1	4,096	17.4
Unknown	28	2.3	6	1.5	688	2.9
5. Lighting Conditions						
Daylight	831	68.7	278	69.0	16,465	69.9
Night	169	14.0	50	12.4	2,656	11.3
Dusk	47	3.9	22	5.5	1,069	4.5
Dawn	13	1.1	3	0.7	142	0.6
Unknown	11	0.9	4	1.0	344	1.5
6. Was Wx a Factor?						
No	976	80.7	327	81.1	18,046	76.6
Yes	234	19.3	76	18.9	5,524	23.4
7. Flight Conditions						
Instrument meteorological conditions	120	9.9	42	10.4	2,980	12.6
Visual meteorological conditions	878	72.6	295	73.2	15,010	63.7
Mixed flight conditions	20	1.7	5	1.2	1,003	4.3
Special VFR conditions (IFR)	1	0.1	-	0.0	23	0.1
Marginal VFR conditions	14	1.1	5	1.2	295	1.3
Unknown	28	2.3	10	2.5	1,161	4.9

The primary problem distribution is fairly consistent with expectations but does set the stage for more detailed analysis in two areas. The less-than-normal incidence of ATC problems is not necessarily predictable, and likewise the higher occurrence of flight crew errors. Determining which types of transgressions and factors contribute to these inconsistencies is a goal of the topical analysis.

It is also useful to observe that airport related problems are noticeably more prevalent in transgression incidents than in ASRS submissions overall. It is hardly surprising that confusing airport layouts, signs, and markings would have a noticeable relationship to runway transgressions. Not expected however, is the diminished contribution of "other" factors which include weather considerations.

Datasets 3 and 4 address timing factors. Distribution of transgression occurrences across the week is entirely consistent with other ASRS data, even exhibiting the markedly reduced weekend rates found throughout the database. The time at which an incident occurred is indicated by quarter of the day. Values for the transgression sets are remarkably consistent with the universe of incidents contained by the database, although there is a slightly higher than normal frequency (3 percent) of runway transgressions during the fourth quarter. This is logical if one assumes that darkness would exacerbate on-airport navigation problems.

Dataset 5 further illustrates the relationship of time to runway transgressions. The frequency of daylight occurrences is virtually identical in all three columns. Although there is a slightly higher propensity for nighttime occurrences, transgressions occurring during the dawn and dusk transition periods do not vary significantly from the norm.

Whereas the most publicized runway transgression accidents seem to involve poor weather conditions, ASRS data indicate that only about 19 percent of runway transgression reports tell of weather-related problems. This rate is actually 4 to 5 percent <u>lower</u> than the database as a whole. The importance of this observation is obvious. Dataset 7 sheds some additional light where it indicates that runway transgressions are <u>less</u> likely to occur

in instrument flight conditions and more likely to occur under visual flight conditions than other types of incidents. This finding, along with the relatively small increase in the incident rate involving airport problems, indicates that the human error aspect of runway transgressions may be more significant when viewed in the absence of expected predisposing conditions.

Operational factors. - Table 2 compares the distributions of several operating factors among the datasets. It can be seen from the first of these that pilot or crewmember reporters (including Air Force and Navy) constitute approximately 60 percent of the runway transgression population and sample sets, while the remaining portion is derived from controllers. This ratio is perfectly congruent with that exhibited by all types of ASRS reports. Since pilots submit the majority of reports, it is interesting to view the breakdown of pilot operational associations. Dataset 2 indicates that air carrier pilots are overwhelmingly the most frequent reporters. It should be further observed that air carrier pilot reports citing runway transgressions exceed the normal rate of air carrier pilot reports present in the total database. These findings should not be misconstrued to mean that air carrier pilots are more prone to causing or being involved in runway transgressions. They do indicate, however, that air carrier crews are more likely to observe transgression errors. Many factors beside involvement may contribute to this; one possibility is that air carrier pilots may frequent airports where local traffic densities and airport configuration might make runway transgressions more likely.

Datasets 3 and 4 provide a demographic picture of the types of aircraft and operators appearing in runway transgression reports. Since more than one aircraft are often present in a single report, the values given are based on the total number of aircraft in the collection. One cannot, of course, assume that all aircraft coded within a report are necessarily pertinent to the transgression incident.

Trend Analysis

Over the past several years, trend analyses of ASRS data have been carried out on an experimental basis. Designing algorithms for trend detection

TABLE 2. OPERATIONAL FACTOR COMPARISONS

Factors	Population		Sample		ASRS Database (5/78-9/83)	
	No. of Rpts	Percent	No. of Rpts	Percent	No. of Rpts	Percent
1. Reporter						
Air Force	22	1.8	7	1.7	1,463	6.2
Crewmember	59	4.9	19	4.7	1,262	5.4
Controller	486	40.1	158	39.2	9,235	39.2
Navy	3	0.2	-	-	469	2.0
Observer	4	0.3	1	0.2	173	0.7
Passenger	-	-	-	-	49	0.2
Pilot	636	52.4	218	54.1	10,892	46.2
Unknown	-	-	-	-	27	0.1
2. Reporter's Operation						
Air Carrier	529	74.0	190	81.2	8,724	62.6
Gen. Aviation & Air Taxi	119	16.6	32	13.7	2,229	16.0
Military	25	3.5	7	3.0	2,013	14.4
Other	4	0.6	1	0.4	138	0.9
Unknown	43	6.0	14	6.0	828	5.9
3. Aircraft Type						
Small aircraft	570	30.4	187	30.4	8,875	23.9
Small transport	300	16.0	101	16.4	5,416	14.6
Light transport	68	3.6	22	3.6	1,178	3.1
Military transport	20	1.1	4	0.7	1,386	3.7
Medium transport	49	2.6	18	2.9	875	2.4
Medium large transport	282	15.0	99	16.1	4,972	13.4
Large transport	338	18.0	110	17.9	6,983	18.8
Heavy transport	52	2.8	16	2.6	980	2.6
Wide-body transport	114	6.1	42	6.8	2,164	5.8
Military training aircraft	10	0.5	3	0.5	987	2.7
Fighter aircraft	14	0.7	3	0.5	1,272	3.4
Bomber	7	0.4	-	-	670	1.8
Other	8	0.4	1	0.2	348	0.9
Unknown	42	2.2	9	1.5	958	2.6
4. Aircraft Operator						
Air Carrier	899	48.0	308	50.1	16,674	45.0
Gen. Aviation & Air Taxi	421	22.5	136	22.1	6,923	18.7
Military	60	3.2	12	2.0	4,607	12.4
Other	18	1.0	8	1.3	450	1.2
Unknown	475	25.4	151	24.6	8,392	22.7

is not difficult and their implementaiton is relatively simple. Problems arise, however, in identifying report sets that exhibit stable biases over time.

For a variety of technical and practical reasons, ASRS trend analysis methods are nonstandard. Historically, ASRS data have exhibited erratic behavior, non-constant cycles, and sharp discontinuities. Thus, techniques that rely upon statistically stationary data are not well suited to ASRS applications. In general, each point in the trend dataset is fitted individually. There are no trend equations or related structures underlying the smoothed trend lines. As each point is fitted, the values of points adjacent to it are used to generate a set of prior hypotheses regarding the "true" value of a given point. The probability that this value is correct is evaluated by comparing it with the actual observed value. This is accomplished by looking at the general scatter in the trend data. The greater the scatter, the more validity is afforded the hypotheses that vary appreciably from each observed value. After evaluating 20 to 30 prior hypotheses for each point, a maximum likelihood estimate of the "true" value is then made. This estimate is referenced as the "smoothed" value in trend depictions.

Figure 2 is an ASRS trend analysis of the population dataset for runway transgressions. The columns of values to the left contain the numeric data for the trend set, the normalizing set, and the relative trend. In this case, the normalizing set consists of all primary reports received over the timespan covered by this study. The relative trend is the runway transgression rate as a percentage of the total primary report rate. The plots to the right correspond to the numeric data. They are read chronologically from top to bottom with higher values appearing toward the right. The rightmost plot depicts the relative trend while the transgression data and normalizing values are charted to the left.

The relative trend for runway transgressions is typical in that it shows a cyclic behavior that appears to be seasonal. Transgression incident reports were at their peak between January 1980 and March 1981. Shortly thereafter, the air traffic controllers' strike occurred and the level of reported transgressions dropped. The seasonal variation remains fairly con-

	RWY INCURSIONS ACTUAL	RWY INCURSIONS SMOOTHED	PRIMARY REPORTS ACTUAL	PRIMARY REPORTS SMOOTHED	PERCENT ACTUAL	PERCENT SMOOTHED	BENCHMARK EVENTS
DEC '78	27	22.4	454	437.2	5.9	5.1	
JAN '79	13	21.8	401	414.5	4.5	5.3	
FEB '79	34	24.2	443	444.3	2.7	5.4	
MAR '79	21	23.4	534	436.4	3.9	5.4	
APR '79	12	24.6	416	455.0	2.9	5.4	
MAY '79	12	25.2	382	453.3	3.1	5.5	
JUN '79	29	25.9	520	473.1	5.6	5.7	AC 00-46A: RPTR IMMUNITY
JUL '79	18	25.8	369	465.5	4.9	5.8	
AUG '79	16	27.7	617	455.9	2.6	5.9	
SEP '79	19	26.9	342	431.3	5.6	6.2	
OCT '79	23	25.2	367	395.9	6.3	6.6	
NOV '79	29	27.8	494	394.8	5.9	2.0	
DEC '79	18	26.3	353	359.4	5.0	7.3	
JAN '80	29	26.4	357	372.3	8.1	7.6	
FEB '80	31	28.5	397	355.0	8.0	2.8	
MAR '80	27	30.4	370	363.8	7.3	7.8	
APR '80	31	30.4	353	392.0	8.8	2.9	
MAY '80	45	32.5	379	410.9	11.9	2.9	
JUN '80	33	31.6	301	402.8	11.0	2.9	
JUL '80	26	32.2	453	422.3	5.7	7.6	
AUG '80	26	29.2	445	365.3	5.8	7.6	
SEP '80	15	26.3	367	345.4	4.1	7.6	
OCT '80	15	23.9	322	307.0	4.7	2.8	
NOV '80	25	22.2	237	276.5	10.5	8.0	
DEC '80	23	22.2	285	272.8	8.1	8.1	
JAN '81	26	22.6	300	274.6	8.7	8.2	
FEB '81	28	23.4	312	286.9	9.0	8.2	
MAR '81	34	23.1	345	283.5	9.9	8.0	
APR '81	18	23.0	283	293.8	6.4	7.8	
MAY '81	20	21.5	281	277.4	7.1	7.2	
JUN '81	23	21.2	278	281.0	8.3	7.6	
JUL '81	29	19.4	314	255.0	9.2	2.3	
AUG '81	5	12.7	140	176.9	3.6	7.2	CONTROLLERS' STRIKE
SEP '81	12	10.8	145	151.8	8.2	2.1	
OCT '81	11	10.8	165	150.7	6.7	2.2	
NOV '81	10	9.9	142	136.8	7.0	7.2	
DEC '81	6	10.1	122	139.2	4.9	2.2	
JAN '82	10	10.2	142	140.9	7.0	7.3	
FEB '82	8	10.5	154	147.8	5.2	7.1	
MAR '82	9	10.8	155	153.7	5.8	7.0	
APR '82	10	11.0	176	159.8	5.7	6.9	
MAY '82	10	11.2	162	163.8	6.2	6.8	
JUN '82	10	10.9	167	163.0	6.0	6.7	
JUL '82	13	11.0	232	168.1	7.8	6.6	
AUG '82	13	10.0	179	154.0	7.3	6.5	
SEP '82	11	10.0	165	152.7	6.6	6.5	
OCT '82	14	9.5	152	143.6	8.6	6.6	
NOV '82	9	10.0	178	148.4	5.1	6.7	N 7210.210: CTLR RPTING
DEC '82	12	9.8	141	142.6	8.5	6.9	
JAN '83	21	10.9	168	155.1	12.5	7.0	
FEB '83	9	11.2	173	161.5	5.2	7.0	
MAR '83	13	12.2	221	177.5	5.9	6.9	
APR '83	10	12.4	177	181.6	5.6	6.8	
MAY '83	21	12.8	196	189.1	10.7	6.8	
JUN '83	14	13.0	202	194.2	6.9	6.2	
JUL '83	8	12.8	205	195.3	3.9	6.5	
AUG '83	15	12.7	219	197.0	6.8	6.5	
SEP '83	13	12.3	184	191.1	7.1	6.4	
OCT '83	4	12.3	199	192.5	2.0	6.4	

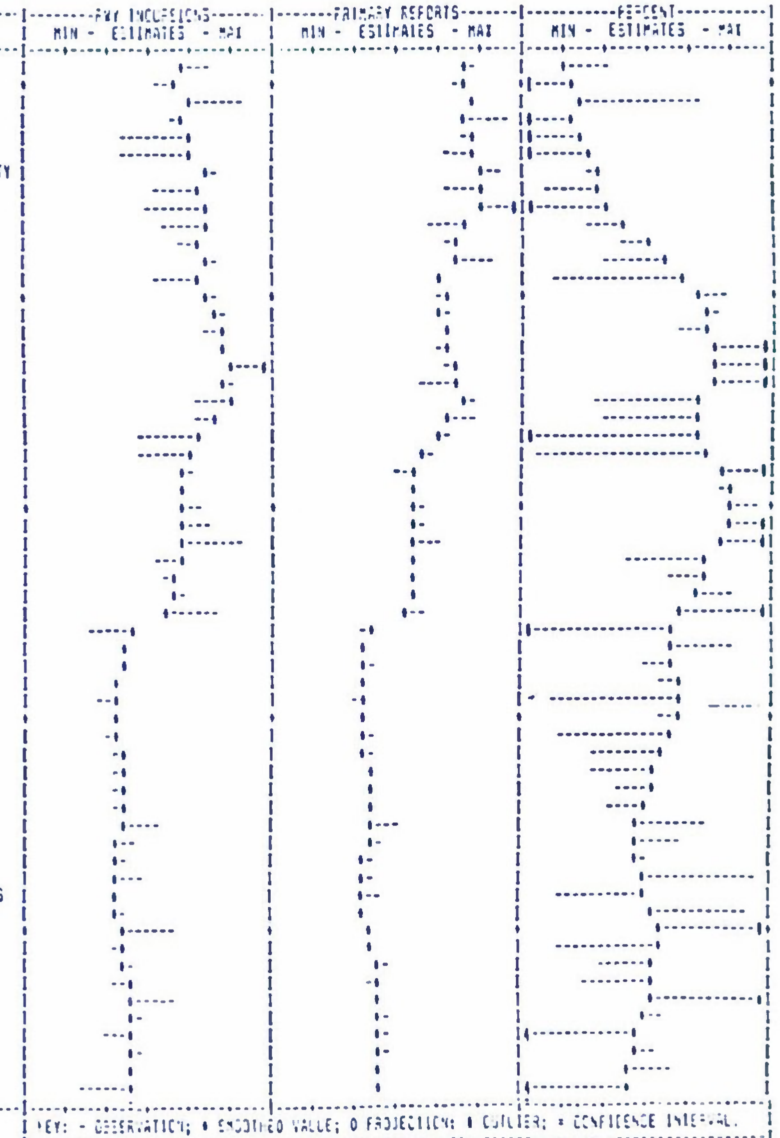

FIGURE 2. ASRS TREND ANALYSIS -- RUNWAY TRANSGRESSIONS

sistent after the controllers' strike with the exception of the period between February and July 1982. During this time, the transgression report rate decreased slightly to its present level. Since the time of the ATC strike, the overall trend of runway transgression incidents reported to ASRS shows a very mild abatement.

Topical Analysis of the Sample Set

The sample set was analyzed by thoroughly reading each report. After initially reviewing every tenth record, lists of authorized entries were compiled to serve as a basis for the analytic process. These lists were appended as was found necessary. The factors utilized in evaluating the sample reports are shown in Appendix A. The factors assigned each report in the sample set are tabulated in Appendix B.

Transgression occurrence typology. - Although occurrences were characterized independently by Type of Occurrence and Enabling Actor, detailed examination of the sample reports showed that the two are logically linked; this linkage is the basis for an occurrence typology that is used as the organizing framework for all subsequent analysis.

Figure 3 shows the percentage distribution of the eight most prevalent incident descriptors (seven categories are included in "all other"). In some instances, occurrences are described as corresponding to more than one type. For instance, an "unauthorized landing" might also be labelled a "wrong airport landing". The tallies, therefore, will not total 100.

Figure 4 shows the distribution of Enabling Actors. The chart shows that pilot errors are far more frequent than those of all other enabling actors combined, totalling approximately 2-1/2 times more than errors by controllers.

Figure 5 shows the six major classifications of runway transgressions categorized by associating the enabling actor with the operational phase of the transgressing aircraft. Each bar is sectioned to illustrate the component conflict severities for that category. Consistent with Figure 3, this

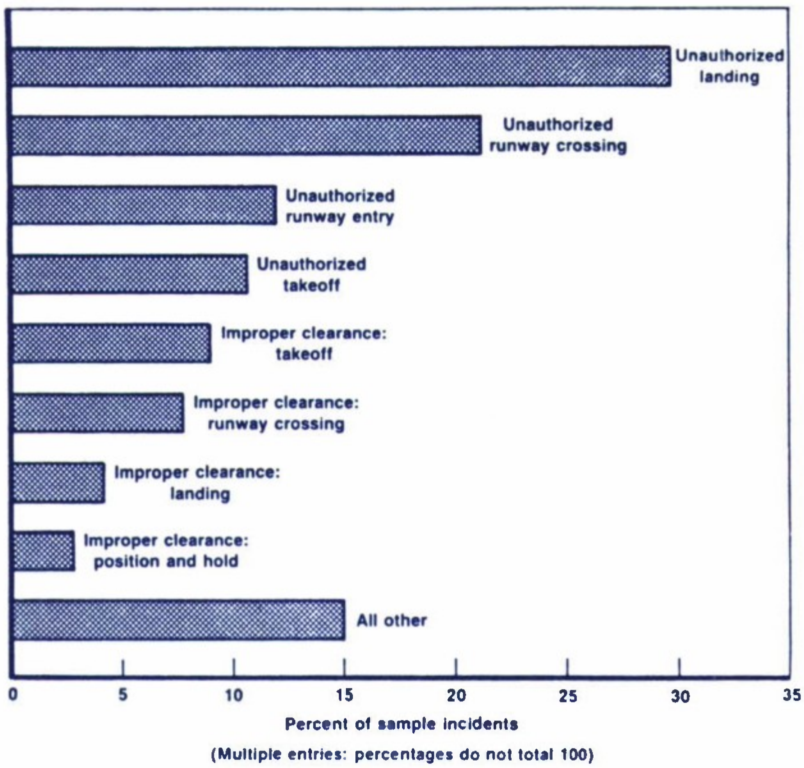

FIGURE 3. TYPES OF OCCURRENCES

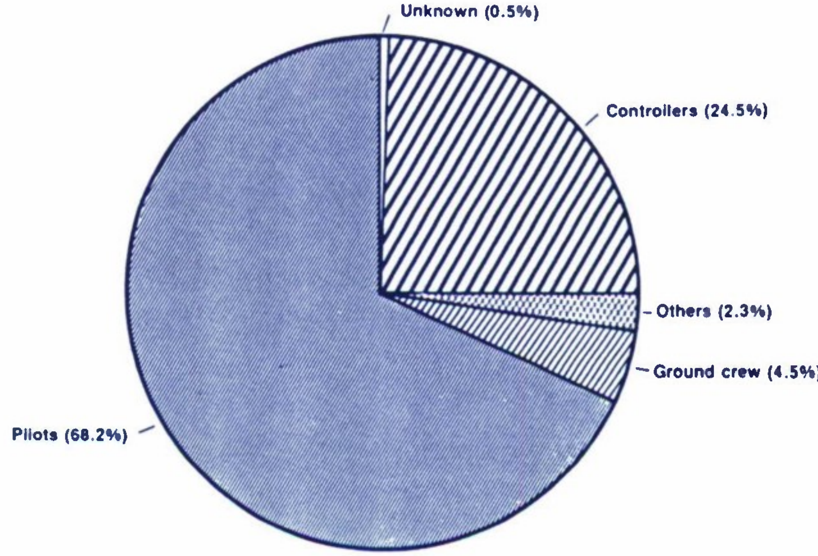

FIGURE 4. ENABLING ACTORS

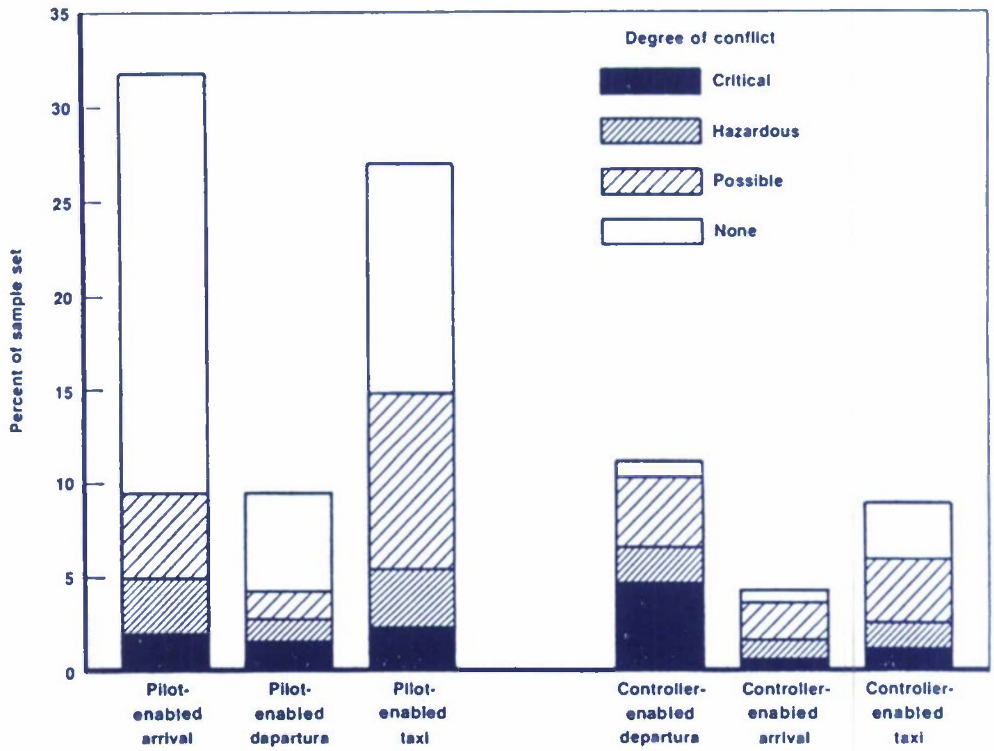

FIGURE 5. RUNWAY TRANSGRESSION INCIDENTS

chart illustrates the preponderance of pilot errors over those of controllers. Within this group, transgressions during arrival and taxi dominate over those occurring during departure. Reports of controller-enabled incidents show that errors during taxi are relatively high. However, instead of being eclipsed by arrival events, as are pilot errors, incidents during the departure phase are predominant.

Figure 5, in its breakdown by conflict severity, provides the basis for the consequence analysis of runway transgressions. Each bar depicts descending severity levels from the bottom to top. It is extremely interesting to note the manner in which the bar relationships change as one progressively ignores the conflicts of lesser severity. The top section of each bar represents the portion of incidents not resulting in a conflict. Looking

first at the pilot-enabled occurrences and eliminating the no-conflict portions, it is seen that the total number of events is cut in half. More significant, however, is that transgressions during taxi now dominate over those during arrival by a considerable amount. On the controller-enabled side, this same selective comparison shows the most noticeable decrease in occurrences during the taxi phase.

The next level in conflict severity involves the "possible" category: separation anomalies where the risk of an actual collision was insignificant. By eliminating these from consideration one is left with a depiction of those runway transgressions where safety was judged to have been compromised. Once again, the picture changes sharply. With respect to pilot-enabled errors, the total number of occurrences in the arrival and taxi categories are nearly equal. Furthermore, the split between those incidents termed "critical" and those considered "hazardous" is also about even. Pilot errors during the departure phase number only half those of the other two categories with an even balance between consequences of a critical or hazardous nature. This result is still consistent with the overall relationships of pilot transgressions regardless of consequence.

To an even greater degree, controller-enabled transgressions involving a hazardous or critical conflict can be seen to stand above the rest during the departure phase. The most remarkable change, however, is the diminishing presence of occurrences during taxi. Those that significantly encroach upon safety are consistent with those in the arrival category.

The balance among all categories can be seen to change noticeably when one considers only hazardous and critical conflicts. Whereas pilot taxi and arrival transgressions dominate the total occurrence comparisons, the controller-enabled departure incidents now take the lead. Equally important, however, is that the predominance of controller departure transgressions consist of critical conflicts which, by themselves, exceed both the hazardous and critical events in the other two controller-enabled types.

Factor analysis. - The factor analysis of the runway transgression sample set was conducted as a two-tiered process. Using the groupings shown in

Figure 5, and within each major enabling factor category, counts of associated factors were totalled. These were then examined in the relation to consequence severity. In this manner it was possible to associate different types of human errors and/or predisposing conditions. Results of the factor analysis are presented in Tables 3 through 20. The tables show the number of citations for various factors. Since each report can have multiple enabling or associated factors, these counts cannot be related uniquely to numbers of incidents.

Tables 3 through 5 document factors pertinent to pilot-enabled arrival transgressions. Table 3 tallies these without regard to their enabling or associated status. They are listed in hierarchical order based upon the total number of reports in which a given factor is found. This value appears in the first column. The second and third columns show, respectively, the number of times a particular factor appears in an incident having a critical or a hazardous consequence.

In Table 4 factors are differentiated by the enabling and associated categories. Enabling factors are shown in the left column and for each one, correlated associated factors are listed in descending order of frequency. The last two columns delineate the number of times each factor is found in occurrences having a critical or a hazardous consequence. Values appearing next to an enabling factor represent only those incidents of a critical or hazardous nature where that factor was deemed as enabling. Similarly, values beside associated factors refer only to citations as an associated factor in critical or hazardous occcurrences.

Table 5 shows the frequency of all factors when aggregated into more general classifications of interest. The original list of 103 factors was compressed into approximately 20 categories. Appendix B shows the factor groupings as a function of each classification. Table 5 is similar to Table 3 in that it does not distinguish between enabling and associated factors, and only the more preponderant listings are shown.

TABLE 3. PILOT-ENABLED ARRIVAL TRANSGRESSIONS: ALL FACTORS

Factor	Number of Citations	Number of Critical Citations	Number of Hazardous Citations
Pilot failure to contact tower during approach	43	1	1
Pilot misorientation	29	6	6
Pilot distraction/flying	23	1	0
Pilot workload	19	0	0
Restricted visibility	14	3	3
Pilot distraction/traffic	13	0	0
Pilot misunderstanding of clearance	13	0	0
Pilot unfamiliarity with airport	12	1	3
Radio communication problem	12	1	3
Pilot inexperience	10	1	2
Training in progress	9	1	1
Airport configuration	9	2	1
Multiple runway operation/parallel	8	2	2
Pilot distraction/unspecified	8	0	0
Pilot failure to follow clearance	8	1	1
Pilot misoperation of radio	8	0	0
Pilot failure to follow standard procedures	7	0	0
Pilot fatigue	7	0	0
Radio equipment problem	7	1	0
Pilot failure to request clearance	6	0	1
High traffic volume	6	1	1
Pilot distraction/equipment failure	5	0	0
Pilot failure to go around	5	3	1
Controller failure to issue frequency change	4	0	0
Multiple runway operation/intersecting	4	0	0
Pilot distraction/radio	4	0	0
Readback problem	4	0	1
Use of nonstandard phraseology	4	1	0

TABLE 4. PILOT-ENABLED ARRIVAL TRANSGRESSIONS: CAUSAL FACTOR CORRELATIONS

Enabling Factors	Number of Citations	Associated Factors	Number of Citations	Number of Critical Citations	Number of Hazardous Citations
Pilot failure to contact tower on approach	43			1	1
		Pilot workload	13	0	0
		Pilot distraction/ flying	6	0	0
		Pilot fatigue	4	0	0
		Pilot distraction/ radio	3	0	0
		Pilot inexperience	3	1	2
Pilot misorientation	29			6	6
		Restricted visibility	6	2	3
		Arpt configuration	6	2	1
		Pilot inexperience	5	-	-
		Multiple runway operation/ parallel	4	2	2
Pilot distraction/flying	14			1	0
		Pilot workload	5	-	-
		High traffic volume	2	1	1
		Clearance revised	2	0	0
Pilot misunderstanding of clearance	12			0	0
		Pilot fatigue	2	-	-
		Readback problem	2	0	1
		Radio equipment problem	2	1	0
		Controller failure to visually locate traffic position	2	0	0
Pilot failure to follow clearance	8			1	1

TABLE 5. PILOT-ENABLED ARRIVAL TRANSGRESSIONS:
AGGREGATED FACTORS

Factor	Number of Citations	Number of Critical Citations	Number of Hazardous Citations
Pilot distraction	54	1	0
Pilot failure to contact tower during approach	43	1	1
Communication problem	42	3	3
Pilot flying tasks	30	2	0
Pilot misorientation	29	6	6
Pilot clearance	26	3	4
Airport geography	21	4	3
Weather	20	3	3
Pilot workload	19	0	0

Tables 3 and 4 show that "pilot failure to contact tower during approach" and "pilot misorientation" are the two most frequently cited factors. Furthermore, they both appear exclusively as enabling factors. The phrase "failure to contact tower" refers to what might be simply described as forgetfulness. This error manifests itself in several ways and is discussed later. "Pilot misorientation" refers to a pilot's or flight crew's continuous awareness of their geographical position. Most often, problems with orientation are accompanied by a restricted visibility condition and non-simple airport configurations. "Pilot inexperience" is also a contributor to such situations. Arrival transgressions covered under this category include wrong-runway landings and sometimes wrong-airport landings. Tables 3 and 4 indicate that transgressions due to pilot misorientation result in a critical or hazardous conflict considerably more often than any other factor. Restricted visibility, primarily an associated factor and predisposing condition, also appears consistently in critical or hazardous incidents -- though much less so than pilot misorientation overall.

When factors are lumped together into topical groups, as shown in Table 5, pilot distractions are more frequently cited than failures to contact the tower. There is probably a fair amount of redundancy of incidents between

these two groupings. There is some justification for grouping distractions, workload, and flying tasks together as workload contributors. Each of these factors is significant in its own right, and if their associated mechanics and effects are consistent to any degree, the combined group would take on extraordinary significance. Also high on the list of aggregated factors are communication and clearance problems. Both are significant contributors to those incidents with more severe consequences.

Tables 6 through 20 show the results of the factors analysis for the five remaining occurrence classifications. The tables are similar to those just discussed.

ASRS reports indicate that taxi transgressions enabled by pilots result overwhelmingly from problems with clearances. In combination with a propensity for pilot misorientation at confusing airports, this accounts for the clear majority of these incident types. Most often, there is some aspect of their clearance that pilots fail to understand. Table 7 indicates that complex airport configurations can exacerbate the effects of this error. However, multiple active runways, clearance expectations, and a failure to readback are significant associated factors. The table also indicates that pilots will sometimes forget to request a clearance when one is required. This is sometimes the result of misorientation. A pilot unaware of his precise position on the airport may inadvertently cross a runway. He knows that clearance for this is required, but realizes his mistake too late to make the request. Communication problems, as indicated in Table 8, are also significant contributors to these incidents. This is not surprising since such factors can often be linked to occurrences involving misunderstood clearances.

The final category of pilot-enabled runway transgressions are those occurring during the departure phase (Tables 9, 10, and 11). As with taxi transgressions, clearance misunderstandings are the predominant contributor. In contrast though, airport layout and other geographical factors are not significantly associated with this. Problems with phraseology, pilot expectations, similar alphanumerics, and intersecting runway operations are most frequently noted as associated factors (Table 10) with intersecting runways

TABLE 6. PILOT-ENABLED TAXI TRANSGRESSIONS: ALL FACTORS

Factor	Number of Citations	Number of Critical Citations	Number of Hazardous Citations
Pilot misunderstanding of clearance	44	4	6
Airport configuration	40	3	5
Pilot misorientation	34	4	2
Pilot distraction/unspecified	16	1	2
Pilot unfamiliarity with airport	15	1	2
Pilot failure to request clearance	14	2	4
Pilot failure to follow clearance	13	1	2
Multiple runway operation/intersecting	11	0	4
Pilot lack of vigilance	11	3	1
Runway/taxiway markings/sign problems	10	0	0
Pilot habit	9	0	0
Radio communication problem	8	2	0
Readback problem	8	0	1
Training in progress	7	0	1
Language problem	7	2	1
Pilot inexperience	6	0	0
Pilot workload	6	1	0
Similar alphanumerics	6	0	1
Unique airport procedures	6	1	1
Complex clearance	5	0	1
Expected clearance	5	0	0
Multiple runway operation/parallel	5	1	1
Airport construction	4	0	0
Frequency congestion	4	0	1
Pilot failure to follow standard procedures	4	0	0
Pilot misunderstanding of standard procedures	4	0	0
Controller workload	3	1	0
Hearback problem	3	0	0
Night operations	3	0	0
Pilot acting on a clrnc for another acft	3	0	2
Pilot distraction/radio	3	0	0
Pilot nonstandard radio procedures	3	1	0
Restricted visibility	3	1	0
Simultaneous radio transmission	3	0	1
Traffic volume	3	0	0
Use of nonstandard phraseology	3	0	0

TABLE 7. PILOT-ENABLED TAXI TRANSGRESSIONS:
CAUSAL FACTOR CORRELATIONS

Enabling Factors	Number of Citations	Associated Factors	Number of Citations	Number of Critical Citations	Number of Hazardous Citations
Pilot misunderstanding of clearance	44			4	6
		Arpt configuration	15	3	5
		Readback problem	7	0	1
		Multiple rwy operation/ intersecting	6	0	4
		Similar alphanumerics	5	0	1
		Expected clearance	4	0	0
		Pilot distraction/ unspecified	4	0	1
		Pilot habit	4	0	0
		Pilot inexperience	4	0	0
Pilot misorientation	29			2	2
		Arpt configuration	13	-	-
		Pilot distraction/ unspecified	5	-	-
		Pilot unfamiliarity with airport	3	1	0
		Radio communication problem	3	2	0
		Training in progress	3	0	1
Pilot failure to request clearance	14			2	4
		Arpt configuration	4	-	-
		Rwy/txwy markings and signs	2	0	0
		Pilot lack of vigilance	2	1	1
		Pilot distraction/ unspecified	2	-	-
		Unique arpt procedures	2	1	1
Pilot failure to follow clearance	13			1	2
		Arpt configuration	8	-	-
		Pilot unfamiliarity with airport	3	-	-
		Rwy/txwy markings and signs	3	-	-
Pilot lack of vigilance	7			2	0
		Arpt configuration	3	-	-
		Pilot workload	2	1	0
Pilot distraction/unspecified	6			1	1
		Arpt configuration	3	-	-
Pilot haoit	4			0	0
		Unique airport procedures	4	-	-

TABLE 8. PILOT-ENABLED TAXI TRANSGRESSIONS: AGGREGATED FACTORS

Factor	Number of Citations	Number of Critical Citations	Number of Hazardous Citations
Pilot clearance problem	81	8	15
Airport geography	56	4	9
Communication problem	38	5	2
Pilot distraction	21	1	3
Runway operations	18	1	5
Pilot habits and expectations	14	0	0
Airport surface	14	0	0
Pilot vigilance	13	4	2
Controller clearance problem	12	0	1

TABLE 9. PILOT-ENABLED DEPARTURE TRANSGRESSIONS: ALL FACTORS

Factor	Number of Citations	Number of Critical Citations	Number of Hazardous Citations
Pilot misunderstanding of clearance	17	2	2
Restricted visibility	7	3	0
Multiple runway operation/intersecting	6	3	1
Similar alphanumerics	6	2	2
Pilot habit	6	0	0
Pilot misorientation	6	3	1
Airport Configuration	5	4	0
Expected clearance	5	0	0
Pilot distraction/unspecified	5	0	0
Pilot failure to follow clearance	5	2	1
Pilot failure to request clearance	5	0	0
Pilot acting on a clearance for another aircraft	3	1	1
Pilot fatigue	3	0	0
Schedule pressure	3	0	0
Training in progress	3	0	1
Unique airport procedures	3	0	0

TABLE 10. PILOT-ENABLED DEPARTURE TRANSGRESSIONS: CAUSAL FACTOR CORRELATIONS

Enabling Factors	Number of Citations	Associated Factors	Number of Citations	Number of Critical Citations	Number of Hazardous Citations
Pilot misunderstanding of clearance	17			2	2
		Nonstandard phraseology	4	1	1
		Expected clearance	4	0	0
		Similar alphanumerics	3	2	2
		Multiple rwy operation/ intersecting	3	3	1
		Pilot inexperience	2	1	1
		Restricted visibility	2	3	0
		Arpt configuration	2	4	0
		Training in progress	2	0	1
		Pilot distraction/ unspecified	2	0	0
Pilot Misorientation	6			3	1
		Restricted visibility	3	-	-
		Intersection takeoffs	2	2	0
		Multiple rwy operation/ intersecting	2	-	-
		Arpt configuration	2	-	-
Pilot failure to request clearance	5			0	0
		Pilot habit	5	0	0
Pilot failure to follow clearance	5			2	1
Pilot acting on clearance for another aircraft	3			1	1
		Similar alphanumerics	2	-	-

TABLE 11. PILOT-ENABLED DEPARTURE TRANSGRESSIONS: AGGREGATED FACTORS

Factor	Number of Citations	Number of Critical Citations	Number of Hazardous Citations
Pilot clearance problem	35	5	4
Communication problem	20	3	5
Airport geography	11	7	1
Pilot habits and expectations	11	0	0
Runway operations	8	5	0
Weather	8	3	0
Controller clearance problem	7	0	0
Pilot misorientation	6	3	1
Airport procedures	3	0	0

TABLE 12. CONTROLLER-ENABLED ARRIVAL TRANSGRESSIONS: ALL FACTORS

Factor	Number of Citations	Number of Critical Citations	Number of Hazardous Citations
Controller misjudgement of traffic spacing	7	1	3
Controller failure to visually locate traffic position	4	0	0
ATCT coordination problem	2	1	0
Airport construction	2	0	0

TABLE 13. CONTROLLER-ENABLED ARRIVAL TRANSGRESSIONS: CAUSAL FACTOR CORRELATIONS

Enabling Factors	Number of Citations	Number of Critical Citations	Number of Hazardous Citations
Controller misjudgement of traffic spacing	7	1	1
Controller failure to visually locate traffic position	4	0	0

TABLE 14. CONTROLLER-ENABLED ARRIVAL TRANSGRESSIONS: AGGREGATED FACTORS

Factors	Number of Citations	Number of Critical Citations	Number of Hazardous Citations
Controller misjudgement of traffic spacing	7	1	3
ATC coordination problem	3	1	1
Airport geography	3	0	2
Communication problem	2	0	0
Controller clearance problem	2	0	0
Runway operations	2	0	1

TABLE 15. CONTROLLER-ENABLED TAXI TRANSGRESSIONS: ALL FACTORS

Factor	Number of Citations	Number of Critical Citations	Number of Hazardous Citations
Controller failure to visually locate traffic position	26	13	6
Restricted visibility	15	10	2
Controller misjudgement of traffic spacing	13	7	1
Multiple runway operation/intersecting	11	6	1
Intratower coordination problem	9	5	1
Controller distraction/unspecified	6	3	1
Intersection takeoffs	6	1	3
Training in progress	5	1	3
Controller workload	4	3	1
"Expedite" clearance	4	1	1
Hearback problem	4	1	1
Use of nonstandard phraseology	4	0	1
Airport configuration	3	1	0
Night Operations	3	2	1
Pilot failure to follow clearance	3	1	0

TABLE 16. CONTROLLER-ENABLED TAXI TRANSGRESSIONS: CAUSAL FACTOR CORRELATIONS

Enabling Factors	Number of Citations	Associated Factors	Number of Citations	Number of Critical Citations	Number of Hazardous Citations
Intratower coord problems	15			3	2
		Training in progress	3	1	1
		Controller distraction/ unspecified	2	0	1
		Restricted visibility	2	0	0
Controller misjudgement of traffic spacing	8			1	2
		Intratower coord problems	3	0	1
		Arpt configuration	2	2	3
Controller failure to issue "hold short" restriction	6			0	0
		Hearback problem	2	0	0
		Arpt configuration	2	-	-
Controller failure to visually locate traffic position	5			1	0
		Arpt configuration	3	-	-
		Multiple rwy operation/ parallel	2	1	0

TABLE 17. CONTROLLER-ENABLED TAXI TRANSGRESSIONS: AGGREGATED FACTORS

Factor	Total Citations	Number of Critical Citations	Number of Hazardous Citations
ATC ccordination problem	19	3	3
Airport geography	18	2	3
Controller traffic sighting and vigilance	10	1	2
Controller misjudgement of traffic spacing	8	1	2
Communication problem	6	1	1
Controller clearance problem	6	1	0
Runway operations	6	1	0

TABLE 18. CONTROLLER-ENABLED DEPARTURE TRANSGRESSIONS: ALL FACTORS

Factor	Number of Citations	Number of Critical Citations	Number of Hazardous Citations
Controller failure to visually locate traffic position	26	13	6
Restricted visibility	15	10	2
Controller misjudgement of traffic spacing	13	7	1
Multiple runway operation/intersecting	11	6	1
Intratower coordination problem	9	5	1
Controller distraction/unspecified	6	3	1
Intersection takeoffs	6	1	3
Training in progress	5	1	3
Controller workload	4	3	1
"Expedite" clearance	4	1	1
Hearback problem	4	1	1
Use of nonstandard phraseology	4	0	1
Airport configuration	3	1	0
Night Operations	3	2	1
Pilot failure to follow clearance	3	1	0

TABLE 19. CONTROLLER-ENABLED DEPARTURE TRANSGRESSIONS: CAUSAL FACTOR CORRELATION

Enabling Factors	Number of Citations	Associated Factors	Number of Citations	Number of Critical Citations	Number of Hazardous Citations
Controller failure to visually locate traffic position	25			13	5
		Restricted visibility	8	10	1
		Multiple rwy operations/ intersecting	4	6	1
		Intersection takeoffs	4	1	3
Controller misjudgement of traffic spacing	12			7	1
		Multiple rwy operations/ intersecting	5	-	-
		Restricted visibility	3	-	-
Intratower coord problems	6			3	1
		Restricted visibility	3	-	-
		Multiple rwy operations/ intersecting	2	-	-
Use of nonstandard phraseology	3			0	1
		Hearback problems	2	0	1
All Others	18				
		Restricted visibility	7	-	-
		Multiple rwy operation/ intersecting	4	-	-
		Intersection takeoffs	4	-	-

TABLE 20. CONTROLLER-ENABLED DEPARTURE TRANSGRESSIONS: INTEGRATED FACTORS

Factor	Number of Citations	Number of Critical Citations	Number of Hazardous Citations
Controller traffic sighting and vigilance	27	14	6
Runway operations	19	8	1
Airport geography	16	8	1
Controller clearance problem	15	6	3
Weather	15	10	2
Controller misjudgement of traffic spacing	13	7	1
ATC coordination problem	10	5	0
Communication problem	10	5	0
Controller distraction	7	3	0
Training in progress	5	1	3

and similar alphanumerics comprising the largest share in the critical and hazardous columns.

Table 10 shows restricted visibility cited more often than any other associated factor, and this is reinforced in Table 9. However, as with runway transgressions during taxi, clearance problems, airport layout, and communication problems top the list of aggregated factor categories.

Tables 12 through 20 cover those occurrences deemed the result of controller error. The first of these involves transgressions during the arrival phase. Although relatively small, this group is dominated by incidents where controllers misjudged traffic spacing. Better than half of these resulted in a critical or hazardous conflict. In contrast, Table 13 indicates that the next three most frequent factors are virtually never found in critical or hazardous events. Table 13 indicates that no correlations can be made with any oft-cited associated factors, while Table 14 shows that the generalized categories also yield no new insights.

The more frequent appearance of controller-enabled departure and taxi transgressions provides a better opportunity for a comparative factors evaluation. As with arrival transgressions, Tables 15, 16, and 17 show that those during taxi often result from traffic spacing misjudgements and controller coordination breakdowns. Intratower coordination problems were sometimes correlated with training, distractions, and restricted visibilities; however, these associations are weak. On occasion, coordination problems were associated with occurrences where misjudgement of traffic spacing was cited as an enabling factor. Table 17 indicates that airport geography is often listed in taxi transgressions, and this is hardly surprising if one surmises that more complex airport layouts are more conducive to confusion during ground traffic control. These situations may also aggravate those occasions where a controller's ability to see ground traffic is impaired. The aggregated factors list shows airport geography more frequently than traffic spacing errors. All in all, however, the occurrence of critical or hazardous conflicts during taxi transgressions is well accounted for by intratower coordination problems alone.

Controller-enabled transgressions during departure operations are previously shown to have a relatively high rate of hazardous and critical conflicts. Tables 18 through 20 support this, but more importantly, they show strong correlations between enabling and associated factors that have not been seen in the other five occurrence classifications. Table 19 indicates that a controllers's failure to sight an aircraft is the most frequent enabling factor, followed, quite far behind, by traffic spacing misjudgements. The most striking revelation from Table 19 is that, regardless of the particular enabling factor, the associated factors are consistent. Chief among these is restricted visibility, followed by operations on intersecting runways and intersection takeoffs. The aggregated factors tabulation supports these observations and further illustrates them by showing the combined effects of all types of runway operation anomalies. Airport layout is frequently cited in these types as it is in others. However, those citations are closely followed in number by controller clearance and weather problems. The large percentage of each factor that occurs in critical/hazardous conflicts is primarily due to the frequency of the more serious consequences when compared to the total incidents in this category. There are, however, notable exceptions to this, and these are discussed.

Recovery process. - The last topical evaluation of the sample dataset involved problem discovery and recovery action. Figure 6 illustrates the percentage of incidents in the sample where various participants recognized a potentially dangerous situation. Approximately 47 percent of the incidents lacked a recovery action. Of those remaining, there is approximately an even probability that a transgression anomaly would be recognized by a pilot or a controller. It can also be seen that a significant portion of incidents involved both pilot and controller recovery initiation.

Specific types of recovery actions are compared in Figure 7. As with initiation, it is possible for multiple recovery maneuvers to occur during a single incident. Each involved pilot has the capability to initiate evasive action and, simultaneously, a controller may also act. Fifty-five percent of the runway transgressions described did not encompass recovery actions. In some instances none were reported and in others there was no time available to act.

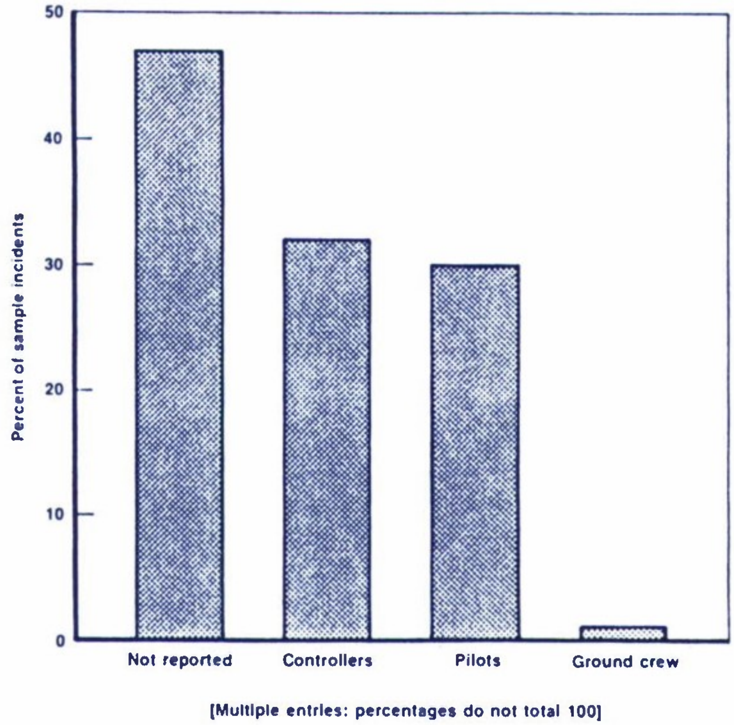

FIGURE 6. PROBLEM DETECTION

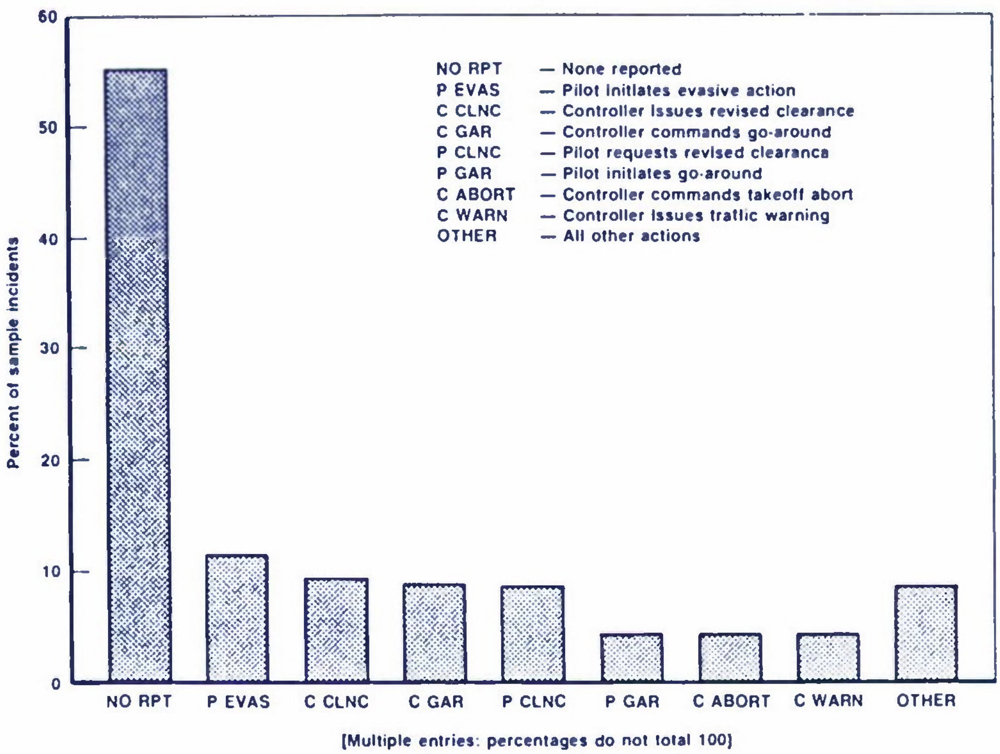

FIGURE 7. RECOVERY ACTIONS

DISCUSSION

It is obvious from the outset that the term "runway transgression" does not pinpoint or define a particular type of occurrence. It is logical to separate incidents by their flight phase and enabling actor, and doing so immediately illustrates the diversity of events that qualify as runway transgressions. This is further exemplified by the various causal structures depicted in the preceding factors tables. At the same time, however, there remain threads of commonality, and these become more apparent in the aggregated factors tables.

Runway transgressions have generated considerable interest in the wake of catastrophic accidents such as Tenerife, and discussions tend to focus on causal elements deduced from theory. As a result, there is a tendency to interpret data with respect to pre-existing theoretical models. Unfortunately, it is easy to look at an incident and attribute its origin to a stereotypical source. Such an approach may or may not be accurate, but a truly objective one requires the construction of a model using the data as foundation.

Pitfalls inherent to this type of research are magnified by the nature of ASRS reports themselves. The aviation community's perception of a hazardous event is probably affected by publicity of other more infamous occurrences. Since ASRS reports are usually taken at face value, there exists some likelihood that a reporter's interpretation of the causal structure will be erroneously influenced. The factors-analysis process attempts to circumvent this situation by objectively correlating a set of subjective labels.

An example of this effect is easily seen in the single parameter breakdowns of the population dataset. Most runway transgression accidents have occurred in poor weather conditions. At first approximation, however, the population set exhibits a 3 percent lower probability of IFR weather and a 9 percent increase in VFR weather when compared to ASRS incidents as a whole. Additionally, weather was cited as a significant factor in less than 20 percent of the transgression events and there is no greater likelihood of a

runway transgression occurring in darkness than that exhibited by other ASRS reports. Taken at face value, these findings stand in contrast to reasonable concerns arising from the accident record. However, there is no doubt that they do represent the characteristics of ASRS reported transgressions. The question that must then be asked is: What is the relationship between runway transgressions that result in accidents and those that result only in ASRS incidents?

Recognition of Inherent Bias

One method of gaining insight into the spectrum of ASRS reported occurrences is depicted in Figure 5. As one looks at the six occurrence classifications, their relative contributions change drastically as less severe incidents are progressively ignored. It is easily seen that pilot-enabled arrival transgressions take a back seat to those occuring during departure when only events resulting in conflicts are considered. Taking the process a step further, these two categories compare equally when only hazardous and critical incidents are viewed. Similar changes in the other classifications lend support to the conclusion that there are fundamental distinctions between incidents differing in consequence, but do little to apprise us of just what these differences are.

In the hope that some deeper understanding of these incident types and their associated consequences will result, it is useful to evaluate Figure 5 in detail at each level of conflict severity. It should first be observed, however, that direct comparisons between all classifications are subject to misinterpretation.

The topical analysis shows that errors committed by controllers are inherently different than those by pilots. By definition, a controller error is usually manifested by the issuance of an improper clearance. A clearance to move on or about an airport creates no problem when only one aircraft is present. Thus, errors by controllers are not operationally noteworthy <u>unless</u> a conflict occurs. This is inherently different from pilot-enabled transgressions wherein error is judged through comparisons of actions taken to actions authorized.

Figure 5 shows the effects of this dual definition: In the three classes of controller-enabled transgressions, the contribution of non-conflict events is quite small. Pilot-enabled transgressions, however, show non-conflict situations to constitute about half the total. There is a temptation to conclude that pilots are more often responsible for runway transgressions, as a result of our definitions.

A more useful comparison among the six occurrence types is achieved by considering only those incidents where a conflict is coded. Immediately, it can be seen that the magnitude of pilot-enabled occurrences is drastically reduced. It is now clear that pilot-enabled taxi transgressions dominate the picture with pilot-enabled arrival and controller-enabled departure incidents a close second. If we eliminate the "possible conflict" incidents, the relationships once again change substantially. Pilot-enabled taxi transgressions take on less significance, and, as mentioned before, appear about equal with pilot arrival transgressions. Both of these follow controller-enabled departure incidents which now has the largest share of the total.

Elimination of occurrences coded as possible conflicts and the significant change this creates must again alert us to the possibility of misinterpretation. There is reasonable justification for believing that, as with the non-conflict incidents, possible conflicts do not exist with equal opportunity in all classifications. One explanation for this lies within its definition and the reporting bias it engenders. As stated previously, possible conflicts are coded when a less-than-standard-separation event occurs. This is usually defined by ATC standards and does not imply that an imminent safety hazard exists. Because of this, pilots are unlikely to know when these separation losses occur. They are neither aware of the standard nor cognizant of a conflict situation. Thus, it is rare that pilots will report such an incident to ASRS.

The final comparison to be made is between those transgressions that resulted only in a critical conflict. Noticeable changes do occur in the controller-enabled categories but none significant enough to alter their relative order. Changes among pilot-enabled categories are even less noticeable.

Since runway transgression classifications exhibit such anomalous behavior when no-conflict and possible conflict occurrences are considered, and since they are not associated with any definitive safety hazards, it seems reasonable to omit them when attempting to quantify the significance of transgression problems. Figure 5 indicates that the greatest influence on the population of critical and hazardous events is exerted by the controller-enabled departure category. It towers over the other classes of controller-enabled incidents and leads pilot-enabled occurrences also. Most important, however, is that incidents of a critical nature account for a clear majority in this category whereas that is clearly not the case in the others. If ASRS data are at all representative of true safety threats then controller-enabled departure transgressions hold the highest potential for danger.

Risk Assessment Based Upon Consequence

Figure 5 may be viewed as a qualitative depiction of risk. According to accepted methods, risk associated with a particular type of event can be quantified by summing the product of frequency and severity:

$$\text{RISK} = \sum_{i} \left[(\text{frequency})_i \, (\text{severity})_i \right]$$

Although no attempt has been made to assign numerical values to the conflict severity levels, it can be seen that, on a relative scale, risk associated with controller-enabled departure transgressions will be relatively high since that category has the highest frequency of critical conflicts and the highest overall number of critical and hazardous incidents. The listings below show the relative rankings of each occurrence classification for each level of consequence severity based upon evaluation of the sample set:

Critical Conflicts

1. Controller-enabled departure
2. Pilot-enabled taxiing
3. Pilot-enabled arrival
4. Pilot-enabled departure
5. Controller-enabled taxiing
6. Controller-enabled arrival

Hazardous Conflicts

1. Pilot-enabled taxiing
1. Pilot-enabled arrival
3. Controller-enabled departure
4. Pilot-enabled departure
4. Controller-enabled taxiing
6. Controller-enabled arrival

Possible Conflicts	No Conflict
1. Pilot-enabled taxiing	1. Pilot-enabled arrival
2. Pilot-enabled arrival	2. Pilot-enabled taxiing
3. Controller-enabled departure	3. Pilot-enabled departure
4. Controller-enabled taxiing	4. Controller-enabled taxiing
5. Controller-enabled arrival	5. Controller-enabled departure
6. Pilot-enabled departure	6. Controller-enabled arrival

As seen under the "No Conflict" heading, controller-enabled transgressions all fall at the bottom lending credence to the earlier contention that, by definition, they are only reported when a conflict exists. Outside of this category, the remaining three lists all indicate that controller-enabled departure, pilot-enabled taxi, and pilot-enabled arrival consistently occupy the top three slots.

Effects of the PATCO Strike

In early August 1981, a labor strike by most of the nation's air traffic controllers left the ATC system in limbo. Most of the striking controllers were terminated and rebuilding of the air traffic control system commenced. The hiring and training of new ATC personnel put the Federal Aviation Administration in the challenging position of maintaining air traffic services at a safe (albeit limited) level until the controller workforce could be expanded. As a result, the public has demanded a more frequent accounting of ATC system performance since the strike.

Figure 8 is identical in format to Figure 5, however, it includes only incidents within the sample set occurring after the controllers' strike. The notable aspect of these results is that they show a substantial change in the relationships among transgression categories. The relative magnitude of pilot-enabled arrival transgressions involving critical or hazardous conflicts has risen remarkably with respect to pilot-enabled taxi transgressions. The most striking factor, however, is the overwhelming domination of controller-enabled departure errors -- especially those of a critical nature. It was apparent from the previous analysis that this type of runway transgression held the greatest risk. Now it appears likely that the overall

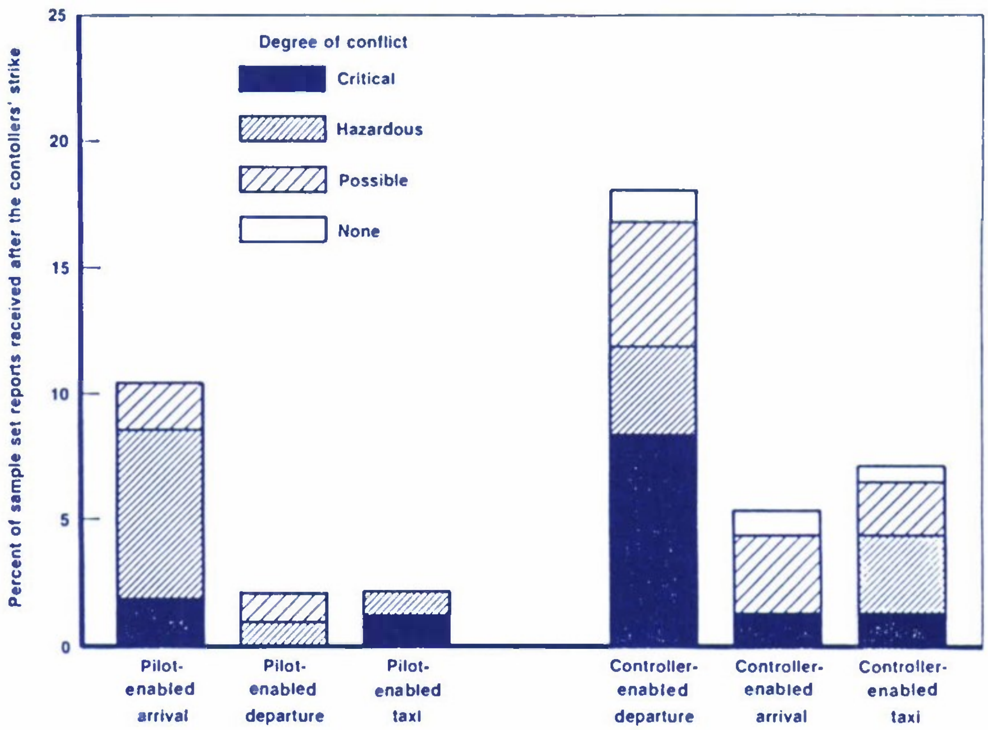

FIGURE 8. POST-STRIKE RUNWAY TRANSGRESSION OCCURRENCES BY SEVERITY OF OUTCOME

situation is being driven by events during the post-strike period. The relative contribution of each type of controller-enabled occurrence remains essentially unchanged. Pilot-enabled arrival transgressions, however, rise significantly above other pilot-enabled incidents in the frequency of safety-threatening events. When compared together, controller-enabled and pilot-enabled transgressions indicate another significant change: Controller-enabled taxi incidents, which represent a considerably smaller portion of the total than pilot-enabled departure and taxi occurrences, now substantially exceed them in the post-strike era.

To summarize these findings, it appears that the record of ASRS reported runway transgressions, during the period following the ATC labor action, shows a significant risk associated with controller-enabled departure and taxi transgressions as well as pilot-enabled arrival transgressions. Other classifications of incidents depict diminishing contributions to the whole. The lists below rank the frequencies of each category of occurrence by level of conflict severity:

Critical Conflicts	Hazardous Conflicts
1. Controller-enabled departure	1. Pilot-enabled arrival
2. Pilot-enabled arrival	2. Controller-enabled departure
3. Pilot-enabled taxiing	3. Controller-enabled taxiing
3. Controller-enabled taxiing	4. Pilot-enabled taxiing
3. Controller-enabled arrival	4. Pilot-enabled departure
6. Pilot-enabled departure	6. Controller-enabled arrival

Possible Conflicts	No Conflict
1. Controller-enabled departure	1. Controller-enabled departure
2. Controller-enabled arrival	1. Controller-enabled taxiing
3. Controller-enabled taxiing	1. Controller-enabled arrival
3. Pilot-enabled arrival	1. Pilot-enabled departure
5. Pilot-enabled departure	5. Pilot-enabled arrival
5. Pilot-enabled taxiing	5. Pilot-enabled taxiing

Without an empirical quantification of the conflict severity levels it is not possible to perform a detailed risk comparison. It is clear, however, that the overall frequency of reported controller-enabled transgressions has increased during the post-strike period when compared to the whole sample.

Since post-strike runway transgressions exhibit notable differences from those of the entire sample set, and without minimizing the implications of these, a caveat is in order: The breakdowns of the various post-strike occurrence classifications by severity level are derived from a set of incidents approximately one-quarter the size of the sample dataset. Thus, relative comparisons amongst these records will be less accurate than those between incident groups from the entire sample. This is purely a function of the size of the sets. Statistically speaking, the confidence levels attributable to the post-strike comparisons will be less.

Causal Structure of Runway Transgressions

The factor analysis, to a first order, pinpoints those errors and predisposing conditions most often associated with a given classification of occurrence. At a deeper level, however, it may be possible to observe consistent relationships among various factors. The following discussions focus on these relationships and the behavior and circumstances most often associated with each occurrence classification.

Pilot-enabled arrival transgressions. - It was noted earlier that pilot-enabled arrival transgressions were most often coded with enabling factors that referenced forgetfulness or a loss of position awareness. Analysis of reports from the sample indicated that a pilot's forgetting to contact the tower on approach was most often accompanied by some form of distraction, including abnormally high cockpit workloads. Often, pilots had no explanation for their oversight and some could not specifically recall whether or not they had talked to the tower. It is clear that, in this type of situation, the crew concept does not always provide the intended redundancy. Frequently, this is due to the distribution of duties assumed by the pilot flying versus those by the pilot not flying. ASRS data have previously engendered research on the distribution of cockpit duties.(9) The sample dataset of runway transgressions indicates that pilots not flying were usually expected to handle communication so that the flying pilot's attention could be totally devoted to aircraft control and guidance. It is clear that this apportionment of responsibility, coupled with the increased workloads inherent during approach, require crewmembers to sacrifice some ability to monitor their partners.

Figures 5 and 8 indicate that, overall, the large number of pilot-enabled arrival transgressions do not result in safety-threatening situations. Interestingly, however, all of the non-conflict incidents were reported prior to the controllers' strike. When added to the relatively large number of hazardous conflicts also occurring post-strike, it could indicate that a change in ASRS reporting biases resulted from the ATC labor action. This notwithstanding, the following reports illustrate that, in IFR conditions, the consequence of this type of error can be very severe:

> "We (medium-large air carrier, A) were waiting for departure from runway 8 at Atlanta. The weather at the time was indefinite zero, sky obscured, visibility 1/4-mile with an RVR on runway 8 of 6100 ft. at approach end, with 1200 ft. midfield, and 800 ft. on rollout. We were number one for departure waiting on arrival of a large transport air carrier, B. Tower asked us to advise them when B went by the approach end of the runway so we could take position. So B landed and we were cleared into position and hold. Also at this time there was a large transport air carrier, C, on the approach to runway 8.

After approximately 2 minutes waiting for B to clear the runway, we were cleared for takeoff. After rolling approximately 200 ft. we were told to hold our position and cancel takeoff clearance due to C still on the approach. At this time tower advised C to go around because we were still sitting on the runway...but we never heard an acknowledgement from C. Still in position, the next thing we knew, C came right over the top of us, missing us by --it seemed like-- inches. His thrust rocked our aircraft as he initiated a go-around. His aircraft came within 5 feet of touching down in the go-around....We later learned that C was never on tower frequency, but still on approach control throughout the entire approach and go-around, and C never heard the go-around call from tower. Obviously C made a normal approach down to minimums, saw us sitting on the runway, and initiated a go-around, missing us by inches."

* * * *

"While making an approach to runway 8 in Atlanta, approach control failed to hand us off to Atlanta tower for landing clearance. I did not find this particularly unusual, for we are often cleared to land on approach frequency at certain facilities....Upon completing our final landing checklist, I realized we had not yet received landing clearance, so I called approacn control.... No response was received and at this time we were in the final and critical phases of the approach...as decision height, approach light sighting, and runway threshold sighting occurred, a medium large air carrier was also sighted (fortunately) in takeoff position on the runway. Immediate go-around was initiated.... Later,...I discovered that tower had been attempting to have us go around on their frequency, and couldn't understand why I didn't comply. It never occurred to them that perhaps I wasn't receiving their transmissions."

These narratives give us the benefit of viewing the situation from both aircraft. Although pilot-enabled landing transgressions may rarely cause a safety-threatening problem, the inherent danger illustrated above is that of being completely without communication during final approach. Approach control is likely to think that a pilot inside the final approach fix is out of his jurisdiction. If the pilot fails to change to tower frequency, there now exists no path for verbal information transfer, and until the aircraft des-

cends below the clouds, pilots cannot receive <u>any</u> information, aural or visual. The foregoing example illustrates that a threat perceived at the decision height limits the ability of a large aircraft to initiate a safe go-around.

Pilot misorientation during arrival is another significant contributor to these transgressions, and the types of associated factors pertinent to this error are quite different from those leading to forgetfulness. Often, errors of this sort result in landings on the wrong runway or even at the wrong airport. The following excerpt shows that a pilot's inexperience can sometimes lead to problems:

> "I sent my student on a solo cross-country flight to BDL airport. Enroute, student believed he was on course but, in fact, was drifting well south of intended course. . . He then spotted PVD airport which he thought was BDL. Since he could not communicate, he elected to land. He followed traffic to runway and landed without further problems. He was met by airport personnel...and was informed he was at Providence. . ."

Experience, however, is not always a saving grace:

> "...I was instructed to land on runway 4L at Honolulu airport. I landed and, on rollout, the tower told me that I had landed on the wrong runway, and said 'no problem'. But sure enough, I had landed on runway 4R. I have probably made in the neighborhood of 5000-6000 landings at Honolulu and have no explanation of how I managed to do that."

The data strongly suggest that there is no one fix for eliminating pilot-enabled arrival transgressions. The most effective attack should probably aim at reducing or mitigating occasions where pilot workload and distractions become exorbitantly high. These conditions can sometimes be exacerbated by certain environmental and operational restrictions including visibility problems, airport layouts, and parallel runway operation. When weather conditions are good, the inherent risks are apparently small, even in the presence of other aircraft. When ceilings and visibilities drop, the data still imply that changes of accidents or critical conflicts remain moderate.

Pilot-enabled taxi transgressions. - Taxi transgressions arising out of pilot error are primarily the consequence of information transfer breakdowns. Clearance misunderstandings, the enabling factor most predominant in the sample, seemed to result from three well-known problems: First is the difficulty in interpreting clearances at airports with complex configurations. Second, are problems related to hearing messages via radio. It is a common occurrence for one pilot to accept a clearance intended for another especially when there is similarity between call signs.(8)

> "I was the captain of air carrier flight A that inadvertently crossed runway 26. . . We taxied on Charlie taxiway to hold short of runway 26 at a fair distance (300-500 ft.). I heard ATC ground control clear us to close up behind a company air carrier and cross 26. . . After that...[the first officer] and I heard the final clearance to cross runway 26. The first clearance in my mind was to close up the distance and cross but it is predicated on closing the distance and for me it requires a final clearance before I would cross. . . Shortly after crossing [the ground controller] informed us that we had crossed without a clearance. It was a very busy time...and many radio transmissions were being blocked at the time, which is not uncommon. What is heard at one end of the airport may not be heard at the other due to distance and power of the blocking radio. We must have heard fragments of other call signs that sounded like ours and the fragments repeated themselves to fit the situation from our viewpoint."

* * * *

> "An aircraft was cleared for takeoff (VFR) from runway 30R. Two airport vehicles (red pickup, black pickup) were holding short of 30R as instructed. The red pickup was at the approach end of 30R and the black pickup was at the departure end of 30R. When the aircraft was cleared for takeoff runway 30R and passed the approach end, I cleared the red pickup to cross 30R. Both vehicles acknowledged and crossed 30R. The black pickup crossed in front of the departing aircraft."

Pilots have also confused their instructions by mishearing taxiway designations and runway numbers. Compensation for such events can often be made by regularizing the use of clearance readbacks. The lack of such readbacks is a significant associated factor in clearance misunderstandings.

The third problem is often a manifestation of pilot complacency. Distractions or preoccupations can lead to pilots responding to clearances they expect rather than those actually received, and this may also result from well-established habit patterns at given locations.

Misunderstanding is not the only clearance-related problem promoting taxi errors. Pilots regularly forget to request clearances and just as often fail to adhere to clearances received. Often these are related. A pilot preoccupied by checklist procedures may taxi across a runway when he was cleared to hold short. Again, it is likely that he was acting out of habit and never really heard the "hold short" instruction.

> "I was captain of commuter aircraft A....I received my clearance and taxi instructions for runway 36. I proceeded to taxi from gate 5 to runway 36 by taxiway B. After I crossed runway 27R using taxiway B, the ground controller proceeded to chew me out for not holding short of an active runway. At that time, I saw what appeared to be aircraft B fly over my left wing in a go-around. The controller claimed I acknowledged the hold short order, but I told him that I did not remember one and I taxied across the runway not seeing the other aircraft."

As with landing transgressions, position awareness plays a noticeable role in taxi errors. A common contributor to this is, once again, distraction or preoccupation. A pilot's unfamiliarity with an airport can be elemental to misorientation, but cockpit preoccupations at fields where a pilot is experienced can lead to similar problems when the airport layout is complex:

> "I taxied out of our gate area and made a left turn onto taxiway H from taxiway C. I continued to taxi east on H which I thought was taxiway 4 going to runway 21C, the runway we had been cleared to. Someway I had in my mind that we had departed the ramp at B instead of C and the left turn had put me on taxiway J. I crossed an active runway (21C) which I thought was old runway 33 which is now taxiway A. We were running our before-takeoff checklist and while making the instrument check I realized we were going the wrong direction. At about the same time ground control called us and said we had crossed an active runway without clearance. We realized this to be true. However out of habit I always make a visual check for traffic when crossing any runway or taxiway. I

checked this time and there were no traffic either T.O. or landing, or taxiing. We changed to the tower and took off on 21C. I believe the incident occurred because I did not take enough time studying the airport page before starting to taxi. I should have had it firmly in my mind just how I was going to get where I was going. . . Waiting to use the takeoff check until I was nearer the takeoff point would be a better procedure. I will do this at all times in the future. I have been flying in and out of this airport for at least 20 years, but many changes have been made and runway 21C used to be 21L. . . I will slow down and take the above steps even if I have departed the gate late."

A comparison of Tables 7 and 10 show that the most common enabling factors in pilot-enabled taxi transgressions are also present in departure transgressions. Again, misunderstanding of a clearance is found most often, with pilot misorientation next. These are followed by failures to request or to follow clearances. There is also some similarity in the associated factors coupled with these, but there are some differences too. Beside those linked with taxi clearance misinterpretations, factors such as use of non-standard phraseology and restricted visibility also appear related. The following reports illustrate that restricted visibilities can present problems for pilots and controllers alike:

"...I was the captain of a medium-large air carrier.... I departed from the terminal...with directions for takeoff from runway 28R. While enroute, the controller changed the takeoff runway to 28L and directed the flight to use taxiway P and runway 14. I proceeded as directed, received clearance, and took off.... It now appears that the flight departed from 28C, not 28L. The weather...was very poor due to low ceilings, rain, and fog. The runways 28L and 28C have no signs to identify which is which. The lights for 28C were on while it was not intended for use."

* * * *

"Aircraft was not visible from tower due to restricted visibility. Aircraft had been issued instructions to taxi to runway 28. Aircraft was given takeoff clearance on runway 28. Aircraft departed runway 32 nearly hitting a maintenance vehicle on runway 32. Vehicle was observed to take evasive action to avoid collision."

Pilot-enabled departure transgressions. - As in other transgression types, the partyline nature of radio communication can contribute to pilot-enabled departure errors too. We have already seen how similar call signs can lead to clearance misunderstandings. In addition, problems with phraseology consistently appear as seeds for transgression events. The next examples depict this and the potential problem caused by multiple runway takeoff operations.

> "...controller clearing flights for takeoff on (intersecting) runways 4L and 32R. Air-carrier flight XXX was cleared into position on runway 32R. Tower had just given [departure] ahead of flight XXX a heading and hand-off to departure control. Tower then instructed: '[Flight XXX], heading 080, departure 125.0'. I responded 'Roger, XXX cleared to go, heading 080.' Tower responded 'Roger XXX'. I then commented to captain that it was, indeed, a strange way to issue a takeoff clearance. Captain started takeoff roll and.... At approximately 60-70 knots, second officer remarked that he thought tower wanted to talk to us - i.e. evidently was unaware we were commencing takeoff roll. I started to respond immediately that flight XXX was taking off, but tower interrupted with 'continue takeoff'. A following transmission by the tower was blocked. (Sounded like a heading instruction). At rotation I notified the tower that XXX was airborne off 32R and asked for confirmation of heading. Tower instructed a turn to a 040 heading and to call departure 125.0. . . In sequenced takeoff traffic it is my opinion that the cockpit crew is very prone to interpret an ambiguous instruction or advisory as a takeoff clearance. The tower controller never said to 'hold' or that flight XXX would be delayed - but gave heading instruction - a very frequent or 'automatic' instruction usually incorporated within a takeoff clearance. My response 'cleared to go' was incorrect. I should have responded 'cleared for takeoff'."

* * * *

> "Two aircraft in position on crossing runways. Air carrier A was cleared for takeoff. Both air carrier A and small transport B began takeoff roll. I believe this was due to frequency interference and congestion. I aborted air carrier A immediately thereby avoiding a possible disaster."

Taxi transgressions resulting from misorientation were sometimes seen accompanied by cockpit preoccupations and exacerbated by a pilot's lack of familiarity with an airport. Neither of these, however, appear prevalent during departure transgressions. Instead, restricted visibility and multiple takeoff origins replace them. At airports with long runways, it is common to find takeoffs being authorized from intersections as well as runway end. The following controller-submitted report demonstrates how these factors can all combine into a problem:

> ". . . small aircraft A was cleared for takeoff on runway 3 from the intersection of runways 9 and 32. The aircraft's initial takeoff roll could not be observed because most of the intersection where the 3 runways cross is obscured by the cab of the old control tower, which supposedly was to have been removed when the new tower was built. It soon became apparent, however, that the pilot had turned onto runway 9 for his takeoff when he was seen rolling down the wrong runway and lifting off over the nose of a light transport B, which had been cleared 'into position and hold' on runway 9 from an intersection downfield, prior to the time small aircraft A was cleared for takeoff on runway 3. . . I believe the greatest contributing factor to the problem is the confusion generated among both pilots and controllers by the complexity of the airport operation and the standard practice of simultaneously utilizing five different runways...for landing and takeoffs. The traffic patterns and departure paths criss-cross in a very complex manner and provide built-in conflicts for the tower controllers who have to struggle just to keep track of all the diverse operations, let alone control them. There are busier airports in the U.S. operating on only 2 or 3 runways and handling more traffic in a safer fashion because traffic flows smoothly in the same direction and resembles some organization."

Pilots sometimes takeoff thinking they are cleared when, in fact, they are not. This is often the result of developed habit patterns that manifest themselves during periods of complacency or high workload. The following report, concerning operations at Kodiak, Alaska, portrays a nonstandard situation but still exhibits this point quite well:

> "The medium-large air carrier flight was cleared into position and hold. Distance from parking to takeoff position is approximately 1500 feet. In that time frame

> the crew must perform...in as fast and safe a rate as possible to be completed and ready for takeoff when in position so as not to waste fuel. Kodiak is a one-way land and takeoff field. At least 90 percent of all takeoffs are runway 7. ATC clearance will not be issued prior to taxi and adds work in an already short time span. The only clearance you ever seem to get is taxi into position and hold regardless of traffic, IFR or VFR. When you ask why we have to hold it is because the tower cannot see the aircraft. This is an unusual procedure, legal, but not normal or safe. Flight [in June] departed without takeoff clearance as another flight did less than two weeks ago. I have talked to five different people that have done the same thing. There is something very wrong, that departures without takeoff clearance are happening."

<u>Controller-enabled arrival transgressions.</u> - Transgressions enabled by controller error are characterized by enabling factors quite different from those where the transgressions are enabled by pilots. The associated factor listings, however, indicate that substantial similarity exists among conditions that predispose both pilots and controllers to error. As mentioned before, arrival transgressions arising from controller error are dominated by mistakes in traffic spacing judgement. The total number of these transgressions is small but, since they appear frequently in conjunction with other types of controller-enabled incidents, it is useful to illustrate them in this context also:

> "Aircraft A was on approach to land, inside the marker. Aircraft B was cleared into position, and was told to expect immediate takeoff. Aircraft A was told to stand by for possible go-around. When aircraft A was less than 75 feet from touchdown, aircraft B rotated, and aircraft A was told to go around. Aircraft B and aircraft A were both climbing out aircraft A was overtaking aircraft B. Aircraft A made a right turn with less than 200 feet lateral, 100 to 150 feet vertical separation...."

* * * *

> "Landing heavy transport A runway 22L crossed runway 27 with large transport B at touchdown and landing roll. I applied anticipated separation which did not occur and had 4000 feet of spacing from B which landed runway 27 as

A crossed that runway. I advised A keep forward speed up, traffic landing on 27 crossing runway. Other factors:...poor arrival spacing by approach control. . ."

* * * *

"The local controller approved the ground controller to allow a car on the active runway. Local control did not see the car nor question the ground controller as to the position of the car and cleared an aircraft to land on the runway that the car was travelling on. The car driver observed the aircraft and moved to the side of the runway....Local controller forgot about the car and therefore failed to coordinate with the ground controller to remove the car from the runway."

<u>Controller-enabled taxi transgressions.</u> - In the past, concern regarding runway transgressions has focused on those involving taxiing aircraft and specifically upon occurrences arising from a coordination problem within the tower. In 1978, the first ASRS study of transgressions responded to this focus when it found that information transfer among all participants was a primary causal factor. Tables 15-17 indicate that coordination between the ground and local controller is, indeed, most often cited in taxiing transgressions. However, coordination problems do not appear nearly as significant in the other classes of controller-enabled occurrences. In the wake of the controllers' strike, training became a much more common activity in the ATC environment. Though training in progress is often cited as an associated factor, at times it is not clear whether it contributed to a given incident:

"I was watching a trainee on local at the time of the incident. We were departing runway 13 and landing runway 22. Medium-large aircraft A requested a departure from runway 22 because of his weight and the wind. Ground taxied him to runway 22 and put him on my frequency. After an arrival, A was told to taxi into position and hold runway 22. Ground asked for a crossing clearance at taxiway E and was denied. Once the arrival had cleared the runway, my trainee cleared A for takeoff runway 22, then turned around and made a blanket statement, 'rolling 22'. Ground control thought my trainee had nodded his head in approval for crossing runway, so as soon as the arrival had passed taxiway E, ground crossed medium-large

aircraft B while A was rolling down the runway. My trainee saw B going onto the runway and, in hopes that he had already switched to tower frequency, started yelling at him to hold his position. By this time A had already seen B going onto the runway and started stopping. No evasive action was necessary since A stopped in time."

Some reports allude to tower coordination errors by implication only. The following submittal by an air-carrier first officer describes the potential danger inherent in an uncoordinated runway crossing which, in this case is exacerbated by some non-common phraseology:

> "Captain made normal approach and landing of air-carrier aircraft A on runway 25L at LAX. Conditions: VMC; weather no factor. As we approached high speed taxiway 42H, I called the tower and asked, "Stop or go?" As we entered the taxiway the tower replied "uh, cleared to cross." The captain released the brakes with velocity about 30 knots. I then turned to check runway 25R and saw air-carrier aircraft B just rotating about 300 feet away. I shouted, 'No, no, no!' and raised my left hand. The captain used maximum braking and we stopped just short of encroaching on runway 25R. I believe we would have had aircraft contact had we not stopped."

As with all controller-enabled incidents, traffic-spacing judgement and vigilance are important factors in taxi transgressions. The next two examples describe problems arising from a controller's not being accurately aware of an aircraft's actual position:

> "We were clear to taxi to 13R hold short of 13L. After holding short of 13L we were cleared to cross 13L hold short of 17. After a few minutes we were told to taxi on to 17 but hold short of 13R. After stopping the local controller cleared a small transport to land right over us. We do not feel he cleared us by very much, but cannot say just how high aircraft B was when he went over us. . ."

* * * *

> Reporter was working ground control, flight data, and clearance delivery positions combined....With approval of local controller he cleared air-carrier A to taxi across 8L at taxiway 20. Local controller said small aircraft B

was 4 mile final. Reporter was then distracted by other duty as air carrier taxied slowly and small aircraft B landed overtop of air carrier. Small aircraft B had broken out of overcast at about 300 ft. AGL and saw air carrier crossing so held altitude until passing overtop. Reporter thinks local controller had misjudged distance from airport on small aircraft B due possibly to poor Brite scope display. Reporter had not given air carrier the traffic on final as he thought it would not be factor. Says it took air carrier more than a minute to taxi across runway.

Controller-enabled departure transgressions. - The final category of controller-enabled errors includes those involving faulty or ill-advised takeoff clearances. These types of incidents have already shown themselves to stand out by the qualitatively high risk associated with them. The factors analysis indicates that they are also unique in terms of their causal structures. Table 19 shows that, regardless of the enabling factor, the predominant associated factors are amazingly consistent. Thus, controller-enabled departure transgressions show much stronger factor correlations than any of the other occurrence types. This is important because, whereas these errors may indeed be the most dangerous, they may also be more understandable and thus, easier to avoid.

As with taxi transgressions, the most common enabling factors are breakdowns in controller vigilance, traffic-spacing judgement, and intra-tower coordination -- all forms of human error. The factors most frequently associated with each of these are restricted visibility and intersecting runway operations -- both considered predisposing conditions. These appear most often even when coupled with enabling factors that appear relatively rarely. Legitimately added to these is the intersection takeoff factor, which is seen to be important in occurrences precipitated by a controller's failure to sight aircraft, as well as the conglomeration of other less frequent enabling factors.

The following ASRS reports exemplify the potential seriousness of a controller's failure to visually locate an aircraft. By characterizing reports with this enabling factor it is implied that the controller had some means of ascertaining an aircraft's position more accurately. Each of the

three examples also involves some form of restricted visibility, demonstrating the various causes of that condition:

> "I gave ground control authorization to allow an airport vehicle to drive onto runway 17 for a runway check. Approximately 3 to 4 minutes later, I cleared small transport A to depart on runway 17 having forgotten about the vehicle. The vehicle was not visible to me when I scanned the runway prior to the departure clearance as the runways were mostly covered with snow and visibility slightly restricted because of it. The vehicle was 4800 ft. down the runway when the jet passed over it. The aircraft said nothing and it was not until the vehicle reported the incident that we realized he was still on the runway. . . Cause: Human error and the fact that the vehicle was not visible to the tower because of runway conditions being partially snow covered."

The next occurrence took place on a clear VMC night:

> "Departure runways 27 and 33L. Our aircraft too heavy for runway 27. Runway 33L was landing runway. Our aircraft was number 3 for departure at the hold behind two small jet aircraft....When the two small jets had departed, our aircraft did not move forward as it was very close to hold point. An aircraft departed off runway 27 and another heavy aircraft was seen on final for runway 33L. Two to three minutes after departure on runway 27 our aircraft was cleared to line up and take off and to expedite. High power was added immediately and the aircraft moved forward - the check completed. The tower then said hold short. The aircraft stopped with its nose over the runway edge white line. Tower asked where was our aircraft - was it short of the line? Captain responded that the nose was over the edge of runway edge white line....Tower said roger and cleared the heavy jet on short final to land. The wing of the widebody passed between 10 - 15 feet over top of our cockpit. Our captain was sorry he did not tell tower that the landing aircraft should go around."

In this report, multiple intersecting runways were in use, however, that is not necessarily related to the cause of the problem. Not so in this next incident, however:

> "...medium-large air-carrier A was cleared for takeoff 10R SFO. As we reached 100 - 105 knots tower said quietly, "Takeoff clearance cancelled." We aborted takeoff. At this moment a small transport, B, on landing

rollout 19R rolled across 10R. This is as close as I have been, including combat. We did not hear the tower give landing clearance to small transport B. Our clearance for takeoff was clearly heard and understood by us and we acknowledged. The large hangars north of runway 10 block the view of the landing area for runway 19. I remember looking in that direction but did not see the landing B. Neither of us saw aircraft B until we had almost stopped and he rolled past our nose. . ."

High-workload and high-traffic-volume situations can also precipitate controller error. The following report illustrates the possible confusion that can develop when takeoffs are being conducted at different points along a runway:

> "I was working [airport] radar which had combined with it [airport] coordination, [airport] tower, and cab coordinator. Small transport A called [airport] tower for departure. I told A to taxi into position and hold. Shortly before this event, small transport B called [airport] tower for departure and I told B to hold short - that small transport A would depart ahead of him. I did observe an A type and a B type holding short of runway 13R at approach end. I didn't see a B type at 13R and taxiway H when I scanned the runway. I scanned runway 13R, cleared A for takeoff, saw A start takeoff roll and scanned runway 13R again. I still did not see a B type at runway 13R at Hotel. I then told B to taxi into position and hold. Shortly after this, small transport A said he just missed B type on runway 13R. B also wanted to know who had passed him. Due to the fact that I was taking care of duties for the 3 other positions I was working, I did not see how close small transport A and small transport B came to one another. Small transport A said he had to maneuver to the left to miss B. I feel a contributing factor to this error was that B did not tell me that he was at runway 13R at Hotel. Had I been told this, I would not have put B on the runway. . ."

A controller's misjudging spacing between aircraft can also lead to a hazardous circumstance when accompanied by intersecting runway operations:

> "First aircraft cleared to land runway 31. Second aircraft called ready for departure runway 36. Brite scope position of first aircraft approximately 1 to 1-1/2 mile on final when second aircraft was cleared for takeoff on intersecting runway. Local controller's attention momentarily diverted to person next to him, upon looking back,

> first aircraft was observed passing through intersection approximately 200 ft. ahead of departing aircraft on runway 36."

In summary, the factors analysis has shown that runway transgressions attributable to both pilot and controller errors arise from three general problem areas:

- Information transfer
- Awareness
- Spatial judgement

Pilot-enabled transgressions indicate that difficulties with clearances, communications, orientation, and preoccupations contribute to each occurrence classification. Transgressions resulting from controller errors are, likewise, consistently due to failures in traffic spacing judgement, traffic sighting, and intra-tower coordination. Factors such as restricted visibility and intersecting runway operations regularly appear as predisposing conditions in both pilot and controller-enabled errors.

CONCLUSIONS

In general, the consequence analysis indicates that the danger inherent to a specific type of transgression can be modeled by a cone of diminishing time and space. The consequences of ASRS incidents are usually found to be worse when aircraft and pilots are faced with decreasing reaction times. As aircraft speed and/or acceleration increases, the risk associated with a transgression error seems to increase. Occurrences during taxi are relatively less risky because they occur at low speeds. Errors that involve arrival aircraft pose a greater threat because touchdown speeds are so much higher. However, even they seem to involve significantly less danger than occurrences with departing aircraft whose speeds are not only high, but steadily increasing.

The consequence analysis further points to the particular risk associated with controller-enabled departure transgressions. The frequency with which these events result in critical conflicts is disproportionately high,

and any attempt to mitigate runway transgression problems must logically focus on this class of occurrences. Analysis of those reports received after the controllers' strike further illustrates that the frequency and severity of these incidents is increasing. In fact, there can be no doubt that this transgression problem has not only worsened in the post-strike period, but that post-strike events are the primary drivers for the enhanced risk that controller-enabled departure transgressions exhibit over the entire timeline of the study.

Coincidentally, although the controller-enabled departure transgression is the highest risk classification, it is also the category that yielded the strongest correlations of causal factors. This means that our understanding of the predisposing conditions and types of errors is more complete for this category than any of the others. The factors analysis shows that departure errors occur more often when visibility is restricted and when multiple take-off runways or multiple takeoff locations are used. Efforts at increasing controller awareness of traffic location and, most importantly, emphasizing the need to make visual contact with traffic during these conditions may have a positive effect on the frequency of these occurrences.

Overall, the same enhanced awareness that will probably reduce controller-enabled departure transgressions will also have desirable effects in reducing the other types of controller-enabled incidents. Problems arise when dealing with these other categories, however, because our knowledge of the conditions that predispose them is less coherent.

The hazards associated with controller errors do not entirely overshadow the effects of pilot-enabled incidents. This is especially true in the post-strike period, where pilot transgressions during arrival are greatly magnified. Any steps that enable pilots to minimize the probability of a misunderstood clearance and decrease cockpit preoccupations are likely to result in a reduction of transgression occurrences.

The only direct and unequivocal measure of risk in aviation is the accident record itself. Close calls, no matter how frequent, do not injure or kill. They can be scary, however, and the question that must be addressed

is whether such incidents justifiably deserve attention. Can the near-accident be presumed to arise from the same types of circumstances and behavior incipient to real accidents? It is not clear that a fully satisfactory answer to this question can be obtained in the near-term. The best we can do now is proceed on the assumption that incident causation is to some measure, related to the causes of accidents, and attempt to use this relationship to motivate constructive change.

Attempts at improving safety must rightfully prioritize themselves on a cost-benefit basis. A fundamental part of this process is to identify operational areas where the greatest improvements may be achieved, and whether methods of instigating change will unacceptably constrain user benefits. This study has made no attempt to quantify runway transgressions in terms of their contribution to the overall risk of flying. What it has done is to compare the various occurrence classifications and their associated risks relative to each other.

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APPENDIX A

SAMPLE DATASET ANALYSIS CODING AND KEY

APPENDIX A: Sample Dataset Analysis Coding and Key

TYPE OF OCCURRENCE

1. Animal on runway
2. Failure to vacate runway
3. Improper landing clearance
4. Improper "position and hold" clearance
5. Improper runway crossing clearance
6. Improper takeoff clearance
7. Improper taxi clearance
8. Taxiway landing
9. Unauthorized landing
10. Unauthorized runway crossing
11. Unauthorized runway entry
12. Unauthorized takeoff
13. Unauthorized taxi
14. Wrong airport landing
15. Wrong runway landing

ENABLING ACTOR

1. Pilot
2. Controller
3. Pilot & controller
4. Ground vehicle operator
5. Animal
6. Pedestrian
7. Unknown

FACTOR LIST (* indicates a predisposing condition)

1. AIRCRAFT EQUIPMENT PROBLEM *
2. AIRCRAFT OPERATING PROCEDURE

3. AIRPORT CONFIGURATION *
4. AIRPORT CONSTRUCTION *
5. AIRPORT LIGHTING *
6. AIRPORT SURFACE CONDITION *
7. AMBIGUOUS CLEARANCE
8. ANTICIPATORY CLEARANCE
9. ATCT COORDINATION PROBLEM
10. ATCT EQUIPMENT PROBLEM *
11. ATCT/APPROACH COORDINATION PROBLEM
12. ATIS PROBLEM *
13. CHART PROBLEM *
14. CLOSED RUNWAY *
15. COCKPIT COMMUNICATIONS PROBLEM
16. COCKPIT COORDINATION PROBLEM
17. COMPLEX CLEARANCE
18. CONTROLLER FATIGUE *
19. CONTROLLER DISTRACTION/TRAFFIC *
20. CONTROLLER DISTRACTION/UNSPECIFIED *
21. CONTROLLER FAILURE TO FOLLOW STANDARD PROCEDURES
22. CONTROLLER FAILURE TO ISSUE "HOLD SHORT" RESTRICTION
23. CONTROLLER FAILURE TO ISSUE CLEARANCE BUT THOUGHT HE HAD
24. CONTROLLER FAILURE TO ISSUE FREQUENCY CHANGE
25. CONTROLLER FAILURE TO VISUALLY LOCATE TRAFFIC POSITION
26. CONTROLLER INEXPERIENCE *
27. CONTROLLER LACK OF VIGILANCE
28. CONTROLLER MISJUDGEMENT OF TRAFFIC SPACING
29. CONTROLLER MISSTATEMENT OF INTENDED CLEARANCE
30. CONTROLLER RADIO OPERATION PROBLEM
31. CONTROLLER WORKLOAD *
32. CONTROLLER/PILOT RELATIONSHIP *
33. CLEARANCE REVISED
34. DIVERSION TO AN ALTERNATE AIRPORT *
35. EMERGENCY IN PROGRESS *
36. EXPECTED CLEARANCE
37. EXPEDITE CLEARANCE *

38. FACILITY MANAGEMENT POLICY *
39. FREQUENCY CONGESTION *
40. FUEL CONSERVATION PRESSURE *
41. GROUND VEHICLE OPERATOR HEARING PROTECTION *
42. HEARBACK PROBLEM
43. IMPRACTICAL CLEARANCE RESTRICTION
44. INTERSECTION TAKEOFFS *
45. LANGUAGE PROBLEM *
46. MULTIPLE RUNWAY OPERATION -- INTERSECTING RUNWAYS *
47. MULTIPLE RUNWAY OPERATION -- OPPOSITE DIRECTION RUNWAYS *
48. MULTIPLE RUNWAY OPERATION -- PARALLEL RUNWAYS
49. Not Used
50. NIGHT OPERATIONS *
51. NO RADIO ABOARD *
52. Not Used
53. NON-STANDARD TRAFFIC PATTERN *
54. PILOT ACTING ON A CLEARANCE FOR ANOTHER AIRCRAFT
55. PILOT DISORIENTATION *
56. PILOT DISTRACTION/EQUIPMENT FAILURE *
57. PILOT DISTRACTION/FLYING *
58. PILOT DISTRACTION/RADIO *
59. PILOT DISTRACTION/TRAFFIC *
60. PILOT DISTRACTION/UNSPECIFIED *
61. PILOT DISTRACTION/WEATHER *
62. PILOT FAILURE TO ASCERTAIN ATIS INFORMATION
63. PILOT FAILURE TO CONTACT ATCT DURING APPROACH
64. PILOT FAILURE TO FOLLOW CLEARANCE
65. PILOT FAILURE TO FOLLOW STANDARD PROCEDURES
66. PILOT FAILURE TO GO AROUND
67. Not Used
68. PILOT FAILURE TO QUESTION IMPROPER CLEARANCE
69. PILOT FAILURE TO RECEIVE "HOLD SHORT" RESTRICTION
70. PILOT FAILURE TO REQUEST CLEARANCE
71. PILOT FAILURE TO REQUEST LANDING TRAFFIC GO-AROUND
72. PILOT FAILURE TO VACATE RUNWAY

73. PILOT FAILURE TO VERIFY NON-STANDARD PROCEDURE
74. PILOT FATIGUE *
75. PILOT HABIT *
76. PILOT INADEQUATE PREFLIGHT PLANNING
77. PILOT INEXPERIENCE *
78. PILOT LACK OF INFLIGHT PLANNING
79. PILOT LACK OF VIGILANCE
80. PILOT MISOPERATION OF RADIO
81. PILOT MISUNDERSTANDING OF CLEARANCE
82. PILOT MISUNDERSTANDING OF STANDARD PROCEDURES
83. PILOT NON-STANDARD RADIO PROCEDURES
84. PILOT UNFAMILIARITY WITH AIRCRAFT *
85. PILOT UNFAMILIARITY WITH AIRPORT *
86. PILOT WORKLOAD *
87. RADIO COMMUNICATION PROBLEM *
88. RADIO EQUIPMENT PROBLEM *
89. READBACK PROBLEM
90. RESTRICTED VISIBILITY *
91. RUNWAY/TAXIWAY MARKINGS/SIGNS PROBLEM *
92. SCHEDULE PRESSURE *
93. SIMILAR ALPHANUMERICS *
94. SIMULTANEOUS RADIO TRANSMISSIONS
95. WAKE TURBULENCE AVOIDANCE *
96. SPECIAL EVENT IN PROGRESS *
97. SPECIAL VFR SITUATION *
98. SUPERVISOR/CONTROLLER RELATIONSHIP *
99. TRAFFIC VOLUME *
100. TRAINING IN PROGRESS *
101. UNIQUE AIRPORT PROCEDURES *
102. UNIQUE AIRPORT RADIO PROCEDURES *
103. UNKNOWN
104. UNKNOWN TRAFFIC *
105. UNTIMELY CLEARANCE
106. USE OF NON-STANDARD PHRASEOLOGY
107. WEATHER PROBLEM *

CONSEQUENCE (CONS)

C - Critical

H - Hazardous

P - Potential

N - None

RECOVERY ACTIONS (RACT)

1. Pilot request for revised clearance
2. Pilot evasive action
3. Controller directed go-around
4. Controller directed takeoff abort
5. No action
6. Pilot made repeated attempts to request clearance
7. Controller issuance of a revised clearance
8. Pilot aborted takeoff
9. Controller directed takeoff abort
10. Pilot initiated go-around
11. Traffic warning issued
12. Pilot vigilance
13. Pilot request for revised clearance
14. Ground vehicle evasive action
15. Controller directed evasive action

APPENDIX B

SAMPLE DATASET FACTOR ASSIGNMENTS

RWY INCURSION SAMPLE DATA SET

ACN	RPTD	GID	RPTR	ATYP1	ATYP2	OPOR1	OPOR2	TYPE1	TYPE2	INIT	EFX1	EFX2	EFX3	AFX1	AFX2	AFX3	AFX4	CONS	RINT1	RINT2	RACT1	RACT2
8864	7805	DEN	P	LGT	.	ACR	.	10	.	3	70	25	.	3	106	.	.	N	P	.	1	.
8975	7805	HNL	C	WDB	WDB	ACR	ACR	5	.	2	103	.	.	9	25	.	.	H	.	.	.	.
9135	7806	ATL	P	MLG	.	ACR	.	9	.	1	80	.	.	59	.	.	.	N	.	.	.	.
9186	7806	AGC	C	SMA	SMA	UNK	UNK	9	15	1	70	64	.	85	.	.	.	H	P	.	2	.
9276	7806	STL	C	SMT	SMA	PER	UNK	10	.	1	81	70	.	.	.	.	.	H	C	P	3	2
9421	7806	DEN	C	SMT	.	ATX	.	9	.	1	55	.	.	3	.	.	.	N	.	.	.	.
9459	7806	MIA	P	LGT	.	ACR	.	10	.	1	81	.	.	36	75	.	.	P	.	.	.	.
9493	7807	SCK	C	SMA	SMA	PER	UNK	9	.	1	70	.	.	.	.	.	.	P	C	.	4	.
9521	7807	TUS	P	SMA	.	PER	.	14	.	1	85	.	.	48	34	.	.	H	C	C	3	7
9571	7807	ITO	P	SMT	.	ATX	.	12	12	1	64	.	.	101	75	.	.	N	P	.	5	.
9614	7807	ATL	P	LGT	SMT	ACR	UNK	9	.	2	.	87	.	0	.	.	.	N	P	.	6	.
9682	7807	DCA	P	LGT	SMA	ACR	UNK	11	.	1	70	75	81	101	3	59	.	P	C	.	7	.
9767	7807	BOS	P	MLG	.	ACR	.	5	.	2	22	.	.	3	.	.	.	N	.	.	.	.
9801	7807	PIA	C	SMT	SMA	PER	PER	12	12	1	55	81	.	.	.	.	.	H	C	P	8	2
9925	7808	PWK	C	SMT	SMA	CFR	FBO	11	.	1	81	55	.	45	66	.	.	H	.	.	.	.
10015	7808	DCA	P	LGT	.	ACR	.	5	.	2	22	.	.	39	42	.	.	N	C	.	5	.
10135	7808	OGG	P	SMT	SMA	ATX	UNK	6	.	2	28	.	.	8	46	.	.	C	C	P	7	2
10213	7808	HNL	P	SMA	SMT	RNT	UNK	12	.	3	81	42	.	75	65	100	93	N	.	.	.	.
10253	7808	FWA	C	SMA	SMA	UNK	UNK	12	12	1	64	81	.	77	100	.	.	H	P	.	2	.
10356	7809	OKC	P	MLG	.	ACR	.	9	15	1	62	.	.	91	106	7	.	N	.	.	.	.
10409	7809	LAX	C	HVT	SMA	ACR	UNK	10	.	1	81	.	.	83	90	45	.	C	P	.	2	.
10428	7809	LAX	C	SMA	HVT	UNK	ACR	10	.	1	81	79	.	45	.	.	.	C	P	.	2	.
10483	7809	DNV	P	SMA	SMA	UNK	UNK	11	.	1	81	75	.	101	3	46	.	P	C	.	5	.
10578	7809	EWR	P	MLG	MLG	ACR	ACR	6	.	2	25	42	.	50	48	9	.	C	P	P	9	11
10633	7809	DCA	P	LGT	.	ACR	.	11	.	3	65	70	29	93	101	3	.	P	.	.	.	.
10666	7809	SAT	P	LGT	SMT	ACR	UNK	5	.	2	28	28	.	9	.	.	.	P	P	.	9	.
10709	7809	SLC	P	MLG	SMA	ACR	UNK	10	.	1	81	.	.	89	48	46	3	P	.	.	.	.
10740	7810	SHV	P	SMA	.	UNK	.	10	.	1	81	.	.	3	46	.	.	N	.	.	.	.
10818	7810	LIH	P	MLG	.	ACR	.	12	.	1	92	70	.	43	102	75	36	N	.	.	.	.
10929	7810	STL	C	MLG	SMT	ACR	ATX	10	.	1	81	85	.	3	.	.	.	H	C	P	10	13
10996	7810	CGX	P	SMT	.	CPR	.	12	.	1	81	.	.	60	36	102	.	N	C	.	.	.
11025	7810	MKC	C	LTT	SMT	SUP	UNK	3	.	2	28	11	.	.	.	.	.	H	P	.	11	.
11154	7810	SFO	P	LGT	.	ACR	.	12	.	1	81	.	.	36	33	.	.	N	C	.	.	.
11213	7811	BOS	P	MLG	.	ACR	.	5	.	2	22	.	.	88	.	.	.	P	C	.	.	.
11255	7811	LGA	C	SMA	LGT	ATX	ACR	10	.	1	87	65	.	.	.	.	.	N	C	.	.	.
11329	7811	PVD	P	SMA	SMT	PER	UNK	5	.	2	28	.	.	9	48	.	.	P	P	.	2	.
11446	7811	DTW	P	LGT	.	ACR	.	10	.	1	55	.	.	60	85	3	76	N	P	C	.	.
11446.1	7811	DTW	P	LGT	.	ACR	.	12	12	1	55	60	.	3	85	75	92	N	.	.	.	.
11501	7811	ISP	C	SMA	SMA	PER	UNK	9	15	1	55	66	.	48	3	.	.	C	.	.	.	.
11620	7811	BOS	P	SMA	LGT	UNK	ACR	11	.	1	70	.	.	48	.	.	.	H	P	.	2	.
11689	7811	EWR	P	LGT	.	ACR	.	9	.	1	88	.	.	.	.	.	.	N	.	.	.	.
11847	7812	MSP	C	SMA	MLG	UNK	ACR	5	.	2	9	25	.	3	48	.	.	C	P	.	2	.
11868	7812	LUK	C	SMA	.	UNK	.	9	15	1	55	.	.	31	99	89	42	H	C	.	3	.
11891	7812	HNL	P	SMA	.	FBO	.	3	.	2	106	.	.	100	75	.	.	N	C	.	.	.
11910	7812	GEG	C	MLG	.	ACR	.	5	.	2	9	.	.	90	20	3	.	P	P	.	2	.
11925	7812	PWK	C	SMA	UNK	PER	UNK	5	.	2	9	28	.	90	3	.	.	P	.	.	.	.
12050	7812	ATL	P	LGT	MLG	ACR	ACR	6	3	2	28	.	.	99	.	.	.	C	C	.	3	.
12050.1	7812	ATL	P	LGT	MLG	ACR	ACR	5	.	2	28	.	.	99	.	.	.	P	.	.	.	.
12153	7812	DET	P	LGT	.	ACR	.	10	.	1	55	55	.	60	92	.	.	N	P	.	.	.
12189	7812	MKK	P	SMA	.	FBO	.	12	.	1	70	.	.	100	15	.	.	N	.	.	.	.
12208	7812	HOU	P	LTT	MLG	CPR	ACR	12	.	1	81	.	.	106	3	.	.	C	C	.	10	.
12356	7901	PHL	P	LGT	SMT	ACR	UNK	10	.	1	81	.	55	3	101	.	.	C	P	.	2	.
12429	7901	OMA	C	UNK	UNK	UNK	UNK	6	.	2	11	.	.	98	.	.	.	N	.	.	.	.
12512	7901	MSY	C	MLG	MDT	ACR	UNK	9	.	1	80	.	.	79	.	.	.	P	P	.	2	.
12544	7901	BUF	C	SMT	.	CPR	.	10	.	4	81	.	.	.	.	.	.	C	.	.	.	.

ACN	RPTD	GID	RPTR	ATYP1	ATYP2	OPDR1	OPDR2	TYPE1	TYPE2	INIT	EFX1	EFX2	EFX3	AFX1	AFX2	AFX3	AFX4	CONS	RINT1	RINT2	RACT1	RACT2
12587	7901	LAS	P	SMA	SMA	UNK	UNK	10	.	1	55	85	.	3	.	.	.	P	C	.	10	.
12635	7901	LAX	P	LGT	SMT	ACR	COM	10	.	1	81	.	.	93	30	37	.	P	C	.	.	.
12664	7902	DEN	P	LGT	MLG	ACR	ACR	9	.	1	80	.	.	39	.	.	.	P	P	.	11	.
12672	7902	IAH	P	MLG	MLG	ACR	ACR	9	.	2	63	60	.	86	.	.	.	N	.	.	.	.
12759	7902	STL	C	MLG	SMT	ACR	CPR	10	.	1	70	.	.	.	.	.	.	C	C	.	12	.
12768	7902	DEN	P	HVT	.	ACR	.	6	.	2	103	.	.	42	.	.	.	N	C	.	.	.
12798	7902	SAN	P	LGT	.	ACR	.	11	.	1	55	.	.	90	.	.	.	N	.	.	.	.
12893	7902	ORD	P	MLG	.	ACR	.	10	.	1	70	.	.	90	88	60	91	P	.	.	.	.
12918	7902	DAY	P	SMA	.	UNK	.	9	.	1	63	.	.	82	.	.	.	N	.	.	.	.
12942	7902	EVV	P	MLG	.	ACR	.	10	.	1	16	.	.	74	18	.	.	N	C	C	4	7
12942.1	7902	EVV	P	MLG	.	ACR	.	12	.	1	16	.	.	74	18	.	.	N	C	.	4	.
12969	7902	TUS	C	SMA	SMA	PER	UNK	11	.	1	66	81	.	31	48	3	.	C	C	.	3	.
12979	7902	TUS	C	SMA	.	PER	.	10	.	1	55	.	.	45	48	13	.	N	.	.	.	.
13022	7902	LAX	P	LGT	SMT	ACR	UNK	11	.	1	55	.	.	3	91	.	.	P	P	.	.	.
13167	7903	LAX	P	MLG	WDB	ACR	ACR	9	.	1	57	63	.	86	33	.	.	N	.	.	.	.
13351	7903	CHA	C	SMA	.	PER	.	10	.	4	81	.	.	.	.	.	.	P	.	.	.	.
13492	7903	HNL	P	SMA	.	FBD	.	9	.	1	87	.	.	99	.	.	.	N	.	.	.	.
13543	7903	PIT	P	MDT	.	ACR	.	9	.	1	63	.	.	78	86	.	.	N	.	.	.	.
13610	7903	HNL	P	SMA	.	PER	.	9	.	1	55	.	.	90	59	.	.	N	N	.	.	.
13669	7903	SNA	P	MLG	.	ACR	.	9	.	1	80	.	.	57	59	.	.	N	C	.	.	.
13716	7903	DRL	P	LGT	.	ACR	.	9	.	1	63	86	.	74	.	.	.	N	.	.	.	.
13853	7904	TUS	C	SMA	.	UNK	.	11	.	1	82	.	.	100	3	.	.	N	.	.	.	.
13918	7904	LDU	C	SMA	.	UNK	.	9	.	1	55	.	.	99	.	.	.	N	.	.	.	.
14078	7904	SAT	P	SMT	SMA	ACR	UNK	6	.	2	106	.	.	44	42	94	.	P	P	P	2	13
14163	7904	PIT	C	MLG	SMT	ACR	UNK	11	.	1	55	.	.	.	.	.	.	P	.	.	.	.
14211	7905	SDL	C	SMA	SMA	UTD	UNK	9	.	1	81	.	.	.	.	.	.	P	.	.	.	.
14281	7905	JET	P	SMT	SMA	CPR	UNK	12	.	1	103	.	.	.	.	.	.	P	P	C	13	3
14281.1	7905	JET	P	SMT	SMA	CPR	UNK	9	.	1	103	.	.	87	80	.	.	N	C	.	7	.
14490	7905	ORD	P	HVT	.	ACR	.	9	.	1	63	.	.	60	.	.	.	N	.	.	.	.
14528	7905	ALN	C	SMA	.	RNT	.	11	.	1	82	.	.	10	.	.	.	N	.	.	.	.
14689	7906	ORD	P	LGT	.	ACR	.	9	.	1	57	.	.	.	.	.	.	N	.	.	.	.
14719	7906	ALN	C	SMA	.	UNK	.	9	.	1	63	.	.	.	.	.	.	N	.	.	.	.
14769	7906	ATL	P	WDB	.	ACR	.	5	.	2	103	.	.	42	.	.	.	N	.	.	.	.
14875	7906	DEN	P	HVT	.	ACR	.	9	.	1	63	16	.	77	.	.	.	N	.	.	.	.
14962	7906	PWK	C	SMT	.	PER	.	10	.	4	103	.	.	27	.	.	.	P	P	.	13	.
15046	7906	SPI	P	MLG	.	ACR	.	5	.	2	22	.	.	32	3	46	75	N	C	.	.	.
15098	7907	FAT	C	SMA	SMA	AGR	UNK	5	.	2	14	25	.	48	3	.	.	P	.	.	.	.
15130	7907	ATL	P	MLG	LGT	ACR	ACR	5	.	2	103	.	.	9	.	.	.	N	.	.	.	.
15151	7906	TDL	C	SMA	SMA	UNK	UNK	6	.	2	25	.	.	31	99	.	.	C	C	C	3	4
15187	7907	ELP	P	LGT	.	ACR	.	9	14	1	55	75	.	.	.	.	.	N	C	.	.	.
15235	7907	CLT	P	MLG	.	ACR	.	9	.	1	57	86	.	24	33	.	.	N	.	.	.	.
15316	7907	BNA	P	MLG	SMA	ACR	UNK	10	.	1	81	70	.	79	.	.	.	H	P	.	2	.
15366	7907	GTF	P	FGT	.	NGD	.	11	.	4	103	.	.	.	.	.	.	C	P	.	11	.
15472	7907	DEN	P	MLG	.	ACR	.	9	.	1	57	.	.	78	59	100	.	N	.	.	.	.
15534	7906	AKR	P	SMA	.	UNK	.	9	.	1	81	.	.	88	106	25	.	N	.	.	.	.
15654	7908	TYS	P	MLG	.	ACR	.	9	.	1	88	.	.	.	.	.	.	N	.	.	.	.
15709	7908	LNK	P	LTT	.	ACR	.	10	.	1	103	.	.	103	.	.	.	P	P	.	2	.
15949	7908	BTV	P	SMA	.	UNK	.	11	.	1	81	.	.	75	4	.	.	N	C	.	.	.
15949.1	7908	BTV	P	SMA	.	UNK	.	10	.	1	103	.	.	4	.	.	.	P	P	.	13	.
16093	7908	LAS	P	MDT	SMT	ATX	ATX	12	.	1	15	.	.	106	.	.	.	H	.	.	.	.
16139	7908	CLE	P	MDT	.	ACR	.	9	.	1	87	.	.	89	48	.	.	N	.	.	.	.
16303	7909	DEN	P	MLG	SMA	ACR	UNK	10	.	1	81	87	.	16	3	46	17	P	P	.	2	.
16326	7909	LAX	P	LGT	SMT	ACR	ACR	12	.	1	81	.	.	93	42	94	.	P	.	.	.	.
16390	7909	CVG	P	SMT	SMA	COM	UNK	10	.	1	81	.	.	17	3	46	89	H	P	.	11	.
16516	7909	FPD	P	SMA	LTT	ATX	UNK	9	.	1	56	56	.	107	.	.	.	N	.	.	.	.

RWY INCURSION SAMPLE DATA SET

ACN	RPTD	GID	RPTR	ATYP1	ATYP2	DPOR1	DPOR2	TYPE1	TYPE2	INIT	EFX1	EFX2	EFX3	AFX1	AFX2	AFX3	AFX4	CONS	RINT1	RINT2	RACT1	RACT2
16639	7906	1SP	P	SMA	.	UNK	.	9	.	1	81	85	.	100	88	.	.	P	C	.	3	.
16679	7910	TMB	P	SMA	.	PER	.	12	.	1	64	.	.	60	27	.	.	N	.	.	.	.
16700	7910	ATL	P	LGT	.	ACR	.	10	.	1	81	.	.	32	.	.	.	N	.	.	.	.
16745	7910	HNL	P	WDB	.	ACR	.	9	.	1	63	.	.	74	.	.	.	N	.	.	.	.
16781	7909	STL	C	SMT	SMT	UNK	UNK	12	.	1	81	.	.	7	106	.	.	F	C	.	10	.
16821	7910	PWK	C	SMA	SMA	UNK	UNK	10	.	1	55	85	.	46	3	100	.	H	P	.	9	.
16845	7910	ARR	P	SMT	.	PER	.	9	12	1	70	65	.	85	75	.	.	N	.	.	.	.
16984	7910	MAF	C	LTT	.	CPR	.	4	.	1	9	.	.	.	.	.	.	P	C	.	7	.
17015	7910	ATL	P	LGT	.	ACR	.	8	.	1	55	.	.	3	.	.	.	N	.	.	.	.
17033	7910	ORD	C	SMT	WDB	CPR	ACR	10	.	1	57	.	.	107	101	46	3	H	P	P	2	11
17147	7911	JFK	C	LGT	LGT	ACR	ACR	10	.	1	55	79	.	3	46	.	.	P	.	.	.	.
17159	7911	BM1	C	SMA	.	UNK	.	11	.	1	85	91	.	50	.	.	.	N	C	.	7	.
17306	7911	BM1	C	SMA	.	UNK	.	10	.	4	70	.	.	.	.	.	.	H	.	.	.	.
17355	7911	YYZ	P	WDB	.	ACR	.	9	.	1	63	.	.	86	85	60	.	N	.	.	.	.
17437	7911	PWK	C	MLG	SMA	CPR	FBO	10	2	1	64	.	.	87	3	.	.	P	C	.	10	.
17453	7911	ATL	P	MLG	.	ACR	.	10	.	1	81	.	.	93	39	94	99	N	.	.	.	.
17485	7911	PWK	C	SMA	SMT	UNK	UNK	11	.	1	64	.	.	55	85	3	87	C	C	C	3	4
17547	7911	CLE	P	LGT	.	ACR	.	9	.	1	81	.	.	75	48	89	42	N	.	.	.	.
17616	7911	RDA	C	MLG	.	ACR	.	11	.	4	55	.	.	3	0	35	91	H	C	.	7	.
17753	7911	CLT	P	LGT	WDB	ACR	ACR	10	.	2	9	25	27	79	3	.	.	P	P	C	9	10
17825	7912	SAT	P	LGT	SMT	ACR	UNK	6	.	2	25	.	.	90	104	.	.	C	.	.	.	.
17845	7912	DCA	P	LGT	MLG	ACR	ACR	12	.	1	81	.	.	46	37	42	106	N	P	.	9	.
17898	7912	LAX	P	HVT	WDB	ACR	ACR	11	.	1	55	.	.	.	.	.	.	P	P	.	9	.
17921	8001	BUR	P	SMA	LGT	PER	ACR	12	.	1	81	.	.	97	36	.	.	N	P	C	2	3
18116	7912	PB1	C	SMA	LGT	RBO	ACR	11	.	1	55	85	.	100	77	.	.	P	P	.	2	.
18185	7912	TUS	C	SMT	SMA	UNK	UNK	7	.	2	9	27	.	100	101	3	.	H	P	.	13	.
18214	8001	DEN	C	SMA	HVT	UNK	ACR	11	.	1	55	.	.	19	87	.	.	C	C	.	7	.
18337	8001	SFO	C	WDB	MDT	ACR	ACR	12	.	1	103	.	.	103	101	47	.	N	.	.	.	.
18364	8001	MKK	C	SMT	.	COM	.	12	.	1	65	.	.	32	38	101	90	N	.	.	.	.
18390	8001	STL	P	SMT	UNK	CIV	UNK	10	.	1	55	.	.	4	85	91	.	P	P	.	2	.
18435	8001	PWK	C	SMA	.	FBO	.	10	.	1	81	64	.	17	3	.	.	N	.	.	.	.
18455	8001	DAY	P	SMT	.	COM	.	1	.	5	103	.	.	103	.	.	.	C	.	.	.	.
18484	8001	PWK	C	SMA	UNK	UNK	UNK	9	.	1	55	64	.	.	.	.	.	P	P	.	2	.
18511	8001	CHA	C	SMA	SMA	UNK	UNK	13	10	1	63	79	.	86	84	85	.	N	.	.	.	.
18604	8001	CID	P	LGT	.	ACR	.	11	.	1	60	.	.	1	.	.	.	P	P	P	13	14
18621	8002	TUS	C	SMA	SMA	UNK	PER	11	.	1	65	81	.	45	.	.	.	P	C	.	7	.
18665	8002	SEA	C	SMT	WDB	ATX	ACR	9	.	1	55	55	.	90	.	.	.	C	.	.	.	.
18718	8002	HNL	P	SMA	.	ATX	.	9	.	1	81	.	.	95	3	.	.	P	C	.	7	.
18764	8002	IAD	C	HVT	SMT	ACR	COM	9	.	1	64	81	.	45	.	.	.	N	C	.	7	.
18805	8002	FWK	C	SMA	SMA	FBO	UNK	10	.	6	103	.	.	87	.	.	.	P	C	C	3	10
18819	8002	PWK	C	SMA	.	RNT	.	10	.	1	55	.	.	100	77	.	.	N	C	.	7	.
18891	8002	SYR	C	MDT	.	CPR	.	12	.	1	55	64	.	90	.	.	.	C	G	.	15	.
18897	8002	MKK	C	SMT	.	ATX	.	12	.	1	103	.	.	32	.	.	.	N	.	.	.	.
18962	8002	ATL	P	HVT	.	ACR	.	10	.	7	81	.	.	37	3	.	.	N	.	.	.	.
19000	8003	MCO	P	LGT	LGT	ACR	ACR	10	.	1	69	.	.	87	42	48	.	N	.	.	.	.
19135	8003	EVV	P	MDT	SMT	ATX	UNK	10	.	1	60	64	.	3	46	.	.	H	P	.	9	.
19196	8003	HPH	C	SMT	.	PER	.	9	.	1	65	.	.	90	34	.	.	N	.	.	.	.
19238	8003	DTW	P	SMT	.	COM	.	5	.	2	42	.	.	3	46	87	.	N	.	.	.	.
19245	8003	ATW	P	MDT	.	ACR	.	9	.	3	11	73	.	.	.	.	.	N	.	.	.	.
19324	8003	BDS	P	MLG	.	ACR	.	10	.	1	81	.	.	74	46	3	.	N	.	.	.	.
19362	8003	LAS	C	SMA	SMA	UNK	UNK	9	.	1	55	64	66	48	.	.	.	C	.	.	.	.
19408	8003	PWK	C	SMA	.	UNK	.	10	.	4	81	.	.	93	106	36	.	H	.	.	.	.
19492	7912	SAN	P	SMA	LGT	PER	ACR	11	.	1	81	.	.	89	79	.	.	P	P	C	11	7
19551	8004	CVG	P	MLG	.	ACR	.	9	.	1	63	.	.	86	.	.	.	N	.	.	.	.
19585	8004	TUS	C	SMA	.	UNK	.	10	.	1	55	.	.	3	82	.	.	N	.	.	.	.

ACN	RPTD	GID	RPTR	ATYP1	ATYP2	OPOR1	OPOR2	TYPE1	TYPE2	INIT	EFX1	EFX2	EFX3	AFX1	AFX2	AFX3	AFX4	CONS	RINT1	RINT2	RACT1	RACT2
19632	8004	DFW	P	LGT	.	ACR	.	10	.	4	70	.	.	89	.	.	.	H	P	.	13	.
19652	8004	PWK	C	.	.	.	.	11	.	4	64	70	.	.	.	.	.	N	.	.	.	.
19701	8004	PWK	C	SMA	.	FBO	.	11	.	1	55	64	.	100	85	.	.	N	.	.	.	.
19715	8004	ALN	C	MLT	SMA	ARM	UNK	9	.	1	63	.	.	100	.	.	.	P	C	.	3	.
19725	8004	LAX	P	SMT	.	ATX	.	9	.	1	81	.	.	74	.	.	.	N	.	.	.	.
19794	8004	PWK	C	SMA	.	UNK	.	11	.	1	55	.	.	85	.	.	.	N	.	.	.	.
19817	8004	PWK	C	.	.	.	.	11	.	4	64	.	.	89	.	.	.	N	.	.	.	.
19883	8005	SDF	C	SMA	MDT	SUP	UNK	6	.	7	9	25	.	19	37	.	.	P	C	.	10	.
19896	8004	DEN	P	LGT	.	ACR	.	10	.	1	64	81	.	91	79	77	.	N	.	.	.	.
19984	8007	HST	A	SMT	.	UNK	.	10	.	4	70	79	.	70	.	.	.	N	C	C	16	3
20039	8004	ORD	P	MLG	.	ACR	.	9	.	1	63	.	.	59	17	86	.	N	.	.	.	.
20073	8005	PWK	C	SMA	.	UNK	.	9	.	1	55	.	.	46	3	.	.	N	C	.	7	.
20130	8005	FRG	C	SMA	.	RNT	.	9	.	1	65	.	.	100	77	.	.	N	.	.	.	.
20137	8005	SEA	P	HVT	.	ACR	.	9	.	1	59	80	.	87	.	.	.	N	.	.	.	.
20219	8005	SAV	P	MLG	.	ACR	.	10	.	1	60	70	64	3	.	.	.	N	.	.	.	.
20246	8005	MSY	P	WDB	.	ACR	.	11	.	4	70	70	.	27	.	.	.	C	.	.	.	.
20288	8005	SJC	C	LTT	SMA	ATX	UNK	12	.	1	79	64	54	93	.	.	.	C	C	.	10	.
20295	8005	DCA	C	SMA	SMA	CPR	LCL	10	.	1	70	64	.	25	9	.	.	H	P	.	13	.
20321	8005	BOS	P	WDB	LGT	ACR	ACR	6	.	2	21	.	.	9	.	.	.	P	P	P	13	2
20339	8005	SFO	P	WDB	.	ACR	.	10	.	1	55	.	.	3	.	.	.	N	P	.	17	.
20370	8005	BM1	C	SMA	.	AGR	.	11	.	1	70	.	.	83	.	.	.	N	C	.	7	.
20414	8005	MSY	C	WDB	.	ACR	.	3	.	2	25	.	.	9	.	.	.	P	G	.	15	.
20453	8005	ORD	P	LGT	LGT	ACR	ACR	6	.	2	25	.	.	31	3	90	.	C	P	.	11	.
20470	8005	BOS	P	HVT	WDB	ACR	ACR	6	.	2	25	43	71	50	90	.	.	C	C	.	7	.
20490	8005	ALN	C	SMA	.	PER	.	9	.	1	63	81	.	65	.	.	.	N	.	.	.	.
20522	8006	PIT	P	MLG	.	ACR	.	9	.	1	63	.	.	16	.	.	.	N	.	.	.	.
20531	8006	CHM	C	SMA	LTT	FBO	CPR	11	.	1	54	.	.	100	.	.	.	P	C	.	3	.
20555	8006	VGT	C	SMT	SMA	ACR	UNK	11	.	1	79	64	.	85	91	.	.	N	C	.	3	.
20565	8006	PHL	c	SMA	SMA	CIV	CIV	3	.	2	25	.	.	31	.	.	.	P	P	.	11	.
20603	8006	HOU	C	MLG	SMT	ACR	ATX	6	.	2	106	.	.	100	29	42	39	H	C	.	10	.
20637	8006	ADQ	P	MLG	.	ACR	.	12	.	1	87	81	75	90	86	.	.	N	.	.	.	.
20648	8006	ROC	P	MLG	SMT	ACR	UNK	3	.	2	28	.	.	46	3	.	.	H	P	.	13	.
20670	8006	DCA	P	LGT	SMT	ACR	COM	11	.	1	70	75	.	101	3	46	.	P	C	.	3	.
20717	8006	ADQ	C	MLG	.	ACR	.	12	.	1	70	81	75	90	.	.	.	N	.	.	.	.
20764	8006	TVC	P	MLG	.	ACR	.	9	.	1	63	.	.	57	86	.	.	N	.	.	.	.
20870	8006	MEM	C	SMA	LTT	UNK	CPR	12	.	1	55	.	.	44	90	46	3	C	.	.	.	.
20870.1	8006	MEM	C	SMA	LTT	UNK	CPR	12	.	1	55	.	.	44	90	46	3	C	P	.	2	.
20870.2	8006	MEM	C	SMA	LTT	UNK	CPR	9	.	1	55	46	3	101	.	.	.	N	.	.	.	.
20870.3	8006	MEM	C	SMA	LTT	UNK	CPR	8	.	1	55	66	.	3	48	101	.	H	.	.	.	.
20913	8007	DAY	C	LGT	.	ACR	.	6	.	2	9	25	.	106	.	.	.	P	.	.	.	.
20960	8007	ATL	P	MLG	MLG	ACR	ACR	10	.	1	54	.	.	39	94	93	.	H	P	.	9	.
21093	8007	DSM	C	SMA	SMT	UNK	SUP	7	.	3	20	66	.	10	90	.	.	P	.	.	.	.
21225	8009	RND	A	MTR	SMA	AIR	UNK	12	.	1	54	.	.	79	.	.	.	P	C	C	7	16
21259	8010	RIV	A	SMA	.	PER	.	9	14	1	55	65	.	77	100	.	.	N	.	.	.	.
21319	8007	BOS	P	WDB	.	ACR	.	9	.	1	56	63	.	16	.	.	.	N	.	.	.	.
21393	8007	HNL	C	SMA	SMT	UNK	ATX	6	.	2	25	64	.	37	98	.	.	P	C	P	10	2
21431	8008	SFO	P	LGT	WDB	ACR	ACR	9	.	1	60	63	.	59	.	.	.	N	.	.	.	.
21449	8007	LAX	P	WDB	LGT	ACR	ACR	5	.	2	9	28	.	106	.	.	.	C	P	.	2	.
21483	8007	ML1	C	SMA	.	UNK	.	5	.	1	81	.	.	27	20	.	.	N	.	.	.	.
21521	8008	ORD	P	LGT	.	ACR	.	10	.	1	70	64	.	3	86	91	.	N	P	.	.	.
21668	8008	CRW	C	LTT	SMA	STA	RNT	10	.	1	58	86	79	3	39	.	.	P	C	.	3	.
21715	8008	OPF	P	MLG	.	NVY	.	11	.	1	81	.	.	60	92	40	83	N	C	.	.	.
21771	8008	IAD	C	MDT	.	CPR	.	11	.	4	70	.	.	9	.	.	.	P	P	.	2	.
21833	8008	HNL	C	MLT	SMA	AIR	UNK	9	15	1	55	85	.	90	100	77	50	C	.	.	.	.
21903	8008	SFO	C	SMA	LGT	PER	ACR	10	.	1	70	55	91	85	.	.	.	P	C	.	.	.

RWY INCURSION SAMPLE DATA SET

ACN	RPTD	GID	RPTR	ATYP1	ATYP2	DPOR1	OPOR2	TYPE1	TYPE2	INIT	EFX1	EFX2	EFX3	AFX1	AFX2	AFX3	AFX4	CDNS	RINT1	RINT2	RACT1	RACT2
21913	8008	ORD	P	LGT	WDB	ACR	ACR	10	.	1	81	.	.	86	31	99	77	P	C	.	10	.
21978	8008	OAK	C	LGT	.	ACR	.	3	.	2	27	.	.	.	.	.	.	H	P	.	.	.
22064	8009	MEX	P	LGT	.	ACR	.	5	.	2	9	.	.	.	.	.	.	N	.	.	.	.
22299	8009	OPF	P	SPC	SMT	CGD	UNK	9	.	1	70	.	.	87	.	.	.	H	C	.	3	.
22371	8009	INT	P	MLG	.	ACR	.	13	.	1	75	92	.	101	.	.	.	N	.	.	.	.
22389	8009	AKN	C	MDT	.	ACR	.	2	.	1	65	.	.	11	.	.	.	N	.	.	.	.
22548	8010	HNL	C	SMT	SMT	ATX	ATX	7	.	2	27	.	.	25	90	19	.	N	P	.	2	.
22605	8010	SEA	C	SMA	.	UNK	.	4	.	2	9	106	.	.	.	.	.	P	G	.	15	.
22666	8010	HFN	C	SMT	SMA	CPR	UNK	10	.	1	70	.	.	79	55	.	.	C	.	.	.	.
22690	8010	PHL	C	LGT	SMT	ACR	ATX	5	.	2	87	.	.	50	.	.	.	P	P	.	2	.
22891	8010	RDA	C	MLG	SMA	ACR	UNK	6	.	2	90	25	.	31	50	.	.	H	P	.	13	.
22929	8010	LAX	P	WDB	.	ACR	.	10	.	1	91	.	.	4	.	.	.	N	P	.	13	.
23013	8011	GNV	C	SMT	SMA	ATX	UNK	9	14	1	55	.	.	.	.	.	.	C	C	.	.	.
23053	8011	ALB	P	MLG	.	ACR	.	9	.	1	63	.	.	86	.	.	.	N	.	.	.	.
23075	8011	PIT	P	MLG	.	ACR	.	10	.	1	58	.	.	58	.	.	.	P	P	.	2	.
23110	8011	FWK	C	SMA	SMA	UNK	UNK	5	.	2	29	.	.	3	.	.	.	C	P	.	2	.
23141	8011	FUL	C	SMA	.	FBD	.	11	.	1	81	.	.	45	55	.	.	N	C	.	7	.
23178	8011	PIT	P	MLG	.	ACR	.	11	.	1	81	.	.	106	.	.	.	N	C	.	7	.
23272	8011	FUL	C	SMA	SMA	UNK	UNK	9	.	1	87	.	.	99	31	.	.	C	C	.	3	.
23315	8012	ICT	C	LGT	SMT	ACR	CPR	2	.	1	72	.	.	6	8	.	.	P	C	.	.	.
23379	8012	BDS	P	MLG	.	ACR	.	9	.	1	63	56	.	.	.	.	.	N	.	.	.	.
23456	8012	PHX	C	SMA	SMA	UNK	UNK	6	.	2	28	.	.	.	.	.	.	H	P	.	1	.
23506	8012	FLL	C	LTT	SMT	UNK	UNK	6	.	2	23	.	.	20	90	.	.	P	P	C	13	3
23539	8012	DEN	P	LGT	.	ACR	.	9	.	1	63	58	.	86	58	85	.	N	.	.	.	.
23550	8012	GNV	C	SMA	SMA	UNK	UNK	9	.	1	63	11	.	90	.	.	.	H	P	.	13	.
23583	8012	EWR	P	MLG	WDB	ACR	ACR	4	.	2	23	39	25	90	20	6	.	C	.	.	.	.
23590	8012	HNL	P	WDB	SMT	ACR	COM	5	.	2	22	.	.	36	17	33	106	N	.	.	.	.
23651	8101	DCA	P	LGT	.	ACR	.	10	.	1	81	.	.	106	36	89	.	N	.	.	.	.
23667	8101	MWH	C	SMT	SMA	COM	UNK	9	.	1	79	73	.	100	77	.	.	P	C	.	3	.
23704	8101	LGA	C	SMT	LGT	ATX	ACR	12	.	1	81	.	.	87	.	.	.	P	C	C	7	16
23801	8101	HOU	C	SMT	SMT	UNK	UNK	4	.	2	25	31	.	20	79	93	44	C	P	.	2	.
23823	8101	HNL	P	WDB	.	ACR	.	12	.	1	81	.	.	100	92	45	74	N	.	.	.	.
23918	8101	DRD	P	LGT	WDB	ACR	ACR	9	.	1	64	.	.	101	32	46	90	P	C	.	3	.
23978	8102	HNL	P	SMA	.	UNK	.	11	.	1	81	82	.	77	.	.	.	N	.	.	.	.
24017	8101	LGA	P	MLG	MLG	ACR	CPR	3	.	2	28	.	.	.	.	.	.	H	.	.	.	.
24110	8102	SNY	P	SMA	.	CIV	.	9	.	1	51	107	.	76	107	.	.	N	.	.	.	.
24204	8102	DRD	P	MLG	.	ACR	.	11	.	1	81	.	.	75	7	86	60	N	P	.	.	.
24232	8102	PIT	P	MLG	.	ACR	.	12	.	1	55	.	.	90	50	33	91	N	.	.	.	.
24243	8102	LGA	C	LGT	LGT	ACR	ACR	6	.	2	64	.	.	8	46	.	.	P	C	.	.	.
24271	8102	HDU	C	SMA	SMT	UNK	UNK	6	.	2	25	.	.	37	20	90	72	H	C	.	.	.
24324	8103	CLE	P	MLG	.	ACR	.	9	.	1	63	60	.	61	57	58	.	N	.	.	.	.
24365	8102	FTW	C	SMA	SMA	PER	PER	4	.	2	25	65	.	44	90	3	.	P	P	.	2	.
24386	8103	HOU	C	SMA	MLG	UNK	ACR	10	.	1	79	64	.	3	.	.	.	P	.	.	.	.
24406	8103	EWR	P	LGT	SMT	ACR	COM	4	.	2	9	.	.	90	.	.	.	C	P	C	2	7
24457	8103	MRY	C	SMT	.	COM	.	3	.	2	79	.	.	4	21	.	.	P	P	.	2	.
24468	8103	HOU	C	MDT	SMT	CPR	CPR	10	.	2	9	25	.	.	.	.	.	P	.	.	.	.
24510	8103	LGB	C	SMA	SMT	RNT	ATX	12	.	1	81	.	.	77	93	46	3	C	C	.	7	.
24522	8102	HOU	C	MLG	SMT	ACR	CPR	12	.	1	81	.	.	39	46	.	.	P	C	.	7	.
24609	8105	WRI	A	SMA	.	PER	.	10	.	4	70	.	.	96	.	.	.	P	C	.	3	.
24609.1	8105	WRI	A	SMA	.	PER	.	10	.	4	70	.	.	96	.	.	.	P	C	.	3	.
24674	8103	LAX	P	WDB	WDB	ACR	ACR	11	.	1	72	64	.	76	3	.	.	P	C	.	3	.
24698	8103	SJC	C	SMA	LGT	PER	ACR	10	2	1	55	.	.	5	87	50	.	P	P	C	13	10
24741	8103	SFO	C	MLG	LGT	ACR	ACR	6	.	2	28	.	.	46	.	.	.	P	.	.	.	.
24781	8103	ORD	P	MLG	.	ACR	.	10	.	2	106	.	.	36	46	.	.	N	.	.	.	.
24870	8104	HNL	P	SMT	.	COM	.	9	.	1	55	.	.	60	48	.	.	N	.	.	.	.

ACN	RPTD	GID	RPTR	ATYP1	ATYP2	OPDR1	OPDR2	TYPE1	TYPE2	INIT	EFX1	EFX2	EFX3	AFX1	AFX2	AFX3	AFX4	CONS	RINT1	RINT2	RACT1	RACT2
24947	8104	RDC	C	SMA	MLG	UNK	ACR	9	.	1	64	.	.	92	66	.	.	P	C	.	3	.
25009	8104	HNL	P	SMT	SMA	CDM	ATX	10	.	1	81	.	.	75	36	.	.	P	P	.	.	.
25060	8104	JFK	P	WDB	WDB	ACR	ACR	3	.	2	28	.	.	.	.	.	.	P	.	.	.	.
25115	8104	MLU	C	SMA	SMA	UNK	UNK	3	.	2	25	.	.	90	.	.	.	P	.	.	.	.
25146	8104	DEN	P	LGT	.	ACR	.	9	.	1	63	57	59	.	.	.	.	N	.	.	.	.
25191	8105	PBF	P	MLT	.	ARM	.	9	.	1	70	.	.	87	.	.	.	N	.	.	.	.
25234	8105	BDS	P	LGT	.	ACR	.	9	.	1	57	63	.	86	31	19	99	N	.	.	.	.
25360	8105	IAH	P	WDB	.	ACR	.	10	.	4	103	.	.	41	27	.	.	P	P	G	2	15
25435	8105	HNL	C	SMT	.	UNK	.	9	.	1	55	.	.	3	45	17	.	N	.	.	.	.
25462	8106	BIL	C	SMA	SMA	FBO	ATX	12	.	1	54	.	.	93	.	.	.	H	C	.	10	.
25529	8106	DEN	P	LGT	WDB	ACR	ACR	9	.	1	56	63	.	1	57	.	.	N	.	.	.	.
25537	8105	DRO	P	MLG	.	ACR	.	9	.	1	57	63	.	.	.	.	.	N	.	.	.	.
25654	8106	SHV	C	LGT	SMT	ACR	ATX	5	.	2	9	21	.	98	20	19	.	P	C	.	3	.
25747	8106	JFK	C	MDT	MLG	CDM	ACR	11	.	1	55	.	.	3	28	.	.	P	P	.	9	.
25777	8106	LGA	C	LGT	MLG	ACR	ACR	6	.	2	28	20	.	.	.	.	.	P	C	.	.	.
25813	8106	DEN	P	LGT	.	ACR	.	9	.	1	59	57	86	99	92	40	2	N	.	.	.	.
25933	8107	BDS	P	LGT	.	ACR	.	10	.	1	81	55	.	3	.	.	.	N	.	.	.	.
25963	8107	PIA	C	MTR	SMT	NGD	UNK	2	.	1	64	.	.	2	37	.	.	P	C	.	.	.
25981	8107	DRO	P	MLG	.	ACR	.	5	.	2	22	.	.	42	.	.	.	N	.	.	.	.
26003	8107	ANC	C	LTT	WDB	CPR	ACR	2	.	1	103	.	.	28	.	.	.	P	P	.	11	.
26076	8107	VGT	C	SMA	FGT	UNK	AIR	9	.	1	55	.	.	85	87	.	.	H	C	.	3	.
26095	8107	RDA	C	SMT	.	PER	.	5	.	2	9	.	.	.	.	.	.	P	C	.	7	.
26119	8107	BDS	P	LGT	.	ACR	.	9	.	1	63	.	.	24	.	.	.	N	.	.	.	.
26155	8107	DCA	C	MDT	SMT	FED	CPR	6	.	2	28	25	.	.	.	.	.	P	C	C	7	16
26193	8103	DSC	A	HVT	SMA	ACR	PER	9	.	1	55	.	.	77	.	.	.	H	.	.	.	.
26271	8110	ACY	A	MLT	.	AIR	.	10	.	4	70	.	.	.	.	.	.	C	P	.	9	.
26349	8108	BDS	C	HVT	LGT	ACR	ACR	3	.	2	28	.	.	8	.	.	.	P	.	.	.	.
26483	8101	DFW	P	LGT	SMA	ACR	UNK	9	.	1	63	66	.	3	.	.	.	C	P	.	9	.
26527	8109	MSY	P	LGT	SMT	ACR	COM	12	.	1	82	.	.	93	46	39	.	H	P	.	13	.
26594	8109	DKC	P	LGT	.	ACR	.	9	.	1	63	.	.	12	.	.	.	N	.	.	.	.
26628	8109	DEN	P	LTT	LGT	CPR	ACR	3	.	2	9	.	.	1	.	.	.	C	P	.	13	.
26644	8109	DSM	C	SMA	SMA	FBO	PER	6	.	3	64	25	.	90	60	.	.	H	C	C	4	16
26668	8110	DRD	P	WDB	.	ACR	.	9	.	1	63	.	.	77	74	86	.	N	.	.	.	.
26689	8110	BRO	C	SMT	.	PER	.	9	.	1	65	70	.	.	.	.	.	N	.	.	.	.
26776	8110	ATL	P	MLG	.	ACR	.	9	.	1	63	60	.	33	86	.	.	N	.	.	.	.
26835	8111	DTW	P	LGT	.	ACR	.	9	.	1	63	57	.	86	105	.	.	N	.	.	.	.
26889	8111	HNL	P	SMT	.	CDM	.	11	.	1	81	.	.	94	93	42	.	N	.	.	.	.
26933	8111	MIA	P	MLG	.	ACR	.	11	.	1	81	.	.	17	3	.	.	N	C	.	7	.
27085	8111	DAL	C	SMT	SMT	UNK	UNK	6	.	2	9	87	.	44	100	46	18	H	P	.	9	.
27166	8111	LAX	P	LGT	.	ACR	.	9	.	1	55	.	.	57	74	85	.	N	P	.	.	.
27199	8112	IAD	P	LGT	.	ACR	.	9	.	1	63	.	.	24	74	.	.	N	.	.	.	.
27278	8201	MDB	P	LGT	.	ACR	.	9	.	1	63	.	.	57	.	.	.	N	.	.	.	.
27315	8201	CVG	P	LGT	SMT	ACR	COM	6	.	2	28	.	.	90	100	46	.	C	P	.	13	.
27383	8201	MDT	P	LTT	.	CPR	.	9	.	1	63	.	.	106	.	.	.	N	.	.	.	.
27459	8202	SFO	P	WDB	WDB	ACR	UNK	5	.	2	9	.	.	3	.	.	.	H	P	P	13	2
27540	8202	PHL	C	SMT	.	CPR	.	6	.	2	9	25	.	90	.	.	.	C	.	.	.	.
27743	8203	MIA	P	LGT	.	ACR	.	10	.	1	65	.	.	31	3	89	42	N	.	.	.	.
27875	8204	DNT	P	SMA	SMA	UNK	UNK	10	.	1	81	.	.	.	.	.	.	P	P	.	13	.
27899	8203	FLL	P	LGT	SMA	ACR	UNK	5	.	2	9	25	.	.	.	.	.	P	P	.	13	.
27954	8204	SAN	P	MLG	LTT	ACR	UNK	7	.	2	9	.	.	37	.	.	.	P	P	.	.	.
28047	8204	DCA	P	MLG	.	ACR	.	11	.	1	55	.	.	60	91	50	3	P	P	C	13	3
28094	8205	HDU	P	MLG	SMT	ACR	UNK	5	.	2	28	.	.	101	3	.	.	H	P	.	2	.
28175	8205	GO1	P	SMA	.	UNK	.	9	.	1	63	.	.	7	77	.	.	N	.	.	.	.
28254	8205	ORD	P	MLG	.	ACR	.	10	.	1	81	.	.	106	.	.	.	N	.	.	.	.
28294	8103	CRQ	P	SMA	.	UNK	.	9	8	1	55	.	.	90	85	.	.	N	.	.	.	.

RWY INCURSION SAMPLE DATA SET

ACN	RPTD	GIO	RPTR	ATYP1	ATYP2	OPOR1	OPOR2	TYPE1	TYPE2	INIT	EFX1	EFX2	EFX3	AFX1	AFX2	AFX3	AFX4	CONS	RINT1	RINT2	RACT1	RACT2
28339	8205	BOS	P	SMT	LTT	COM	COM	6	.	2	25	.	.	90	.	.	.	C	C	.	4	.
28502	8206	HNL	P	MLG	.	ACR	.	9	.	1	63	.	.	46	24	.	.	N	.	.	.	.
28539	8207	DTW	C	SMT	.	CPR	.	3	.	2	25	.	.	4	18	68	.	N	.	.	.	.
28573	8207	CDW	P	SMA	UNK	RNT	UNK	3	.	2	29	.	.	87	.	.	.	P	C	.	16	.
28648	8207	RDC	P	MLG	.	ACR	.	9	.	1	80	81	.	57	.	.	.	N	.	.	.	.
28719	8207	MSP	F	LGT	.	ACR	.	9	.	1	81	54	.	86	.	.	.	N	.	.	.	.
28754	8207	CVG	P	SMT	LTT	COM	UNK	10	.	1	60	79	.	86	.	.	.	C	P	C	2	12
28789	8207	ANC	P	HVT	.	SUP	.	8	9	1	55	90	85	88	60	59	13	N	.	.	.	.
28845	8208	HNL	P	SMT	MLG	COM	ACR	11	.	1	81	.	.	93	47	.	.	P	P	.	2	.
28893	8208	HPN	C	LTT	LTT	CPR	CPR	11	13	1	65	.	.	103	.	.	.	P	C	.	3	.
28917	8208	ISP	P	SMA	SMA	UNK	UNK	6	.	2	25	.	.	48	.	.	.	P	P	C	13	3
28968	8208	LGA	P	LGT	LGT	ACR	ACR	6	.	2	28	25	.	46	.	.	.	C	P	.	11	.
29052	8209	PBI	P	LGT	.	ACR	.	10	.	1	80	70	.	60	.	.	.	N	.	.	.	.
29105	8209	PIT	P	MLG	.	ACR	.	9	.	1	88	80	.	10	102	.	.	N	.	.	.	.
29120	8209	MIA	P	LGT	.	ACR	.	9	.	1	63	.	.	57	.	.	.	N	.	.	.	.
29152	8209	MDH	C	MOT	SMA	COM	OGA	6	.	2	28	.	.	100	38	90	.	N	.	.	.	.
29336	8210	LAX	P	WDB	.	ACR	.	9	.	1	86	.	.	59	90	2	.	N	.	.	.	.
29364	8210	JFK	C	HVT	WDB	ACR	ACR	11	.	1	55	.	.	3	17	33	45	N	P	C	13	.
29441	8211	BHM	P	LTT	SMT	CPR	UNK	10	.	1	64	.	.	99	39	.	.	N	P	.	9	.
29530	8211	ABO	C	MTR	SMT	AIR	OGA	4	.	2	25	.	.	44	.	.	.	H	C	C	7	16
29593	8211	ATW	P	SMT	SMA	ACR	UNK	9	.	1	103	.	.	87	90	.	.	H	P	.	11	.
29617	8212	LGA	C	MLG	MLG	ACR	ACR	5	.	2	9	.	.	100	99	.	.	C	P	C	9	16
29650	8212	XYZ	P	LGT	.	ACR	.	12	.	1	60	70	.	74	86	.	.	N	.	.	.	.
29706	8212	OHN	C	SMT	SMT	ATX	ATX	6	.	2	28	.	.	20	46	64	.	C	.	.	.	.
29755	8212	ORD	P	MLG	.	ACR	.	10	.	1	81	87	.	93	3	44	89	N	C	.	7	.
29798	8301	DEN	P	LGT	MOT	ACR	ACR	3	2	2	28	.	.	48	72	.	.	P	P	C	2	3
29848	8301	IND	C	SMA	.	PER	.	5	.	2	9	.	.	.	.	.	.	N	.	.	.	.
29855	8301	ATW	P	SMT	.	PAX	.	10	.	1	60	.	.	100	.	.	.	N	.	.	.	.
29971	8301	ONT	C	MLG	SMA	ACR	OGA	5	.	2	28	.	.	20	15	.	.	H	P	.	2	.
29997	8301	SFO	P	MLG	SMT	ACR	COM	6	.	2	9	25	.	90	46	.	.	C	C	C	10	16
30033	8302	ALB	P	SMT	.	ACR	.	9	.	1	57	63	.	81	90	58	86	N	.	.	.	.
30055	8301	TPA	P	LGT	.	ACR	.	9	.	1	63	57	.	.	.	.	.	N	.	.	.	.
30072	8301	APA	C	SMA	SMA	OGA	OGA	2	.	2	88	66	.	63	19	42	90	H	P	.	13	.
30118	8302	HOU	P	MLG	.	ACR	.	9	.	1	55	60	.	.	.	.	.	N	P	C	13	.
30148	8301	OFW	P	UNK	.	ACR	.	13	.	1	60	.	.	75	36	3	.	P	P	C	.	.
30198	8302	MKE	C	LTT	.	ACR	.	6	.	2	25	.	.	.	.	.	.	H	.	.	.	.
30311	8303	COS	P	MDT	.	ACR	.	10	.	1	81	.	.	37	88	36	89	N	.	.	.	.
30393	8303	CRG	P	SMA	SMA	PLS	UNK	9	.	1	57	.	.	88	90	106	.	C	C	.	7	.
30495	8303	RST	P	LGT	MDT	ACR	ACR	9	.	1	63	.	.	.	.	.	.	N	.	.	.	.
30599	8304	CVG	P	LGT	SMA	ACR	UNK	10	.	1	81	.	.	60	89	.	.	N	.	.	.	.
30707	8304	ORD	P	LGT	.	ACR	.	12	.	1	81	.	.	17	106	36	89	N	.	.	.	.
30753	8304	PHX	P	LGT	SMA	ACR	OGA	11	.	1	81	54	.	44	60	.	.	H	C	.	3	.
30792	8305	PVO	P	SMA	.	FBO	.	9	14	1	55	.	.	87	77	100	.	N	.	.	.	.
30802	8305	ONT	C	MLG	SMT	ACR	ATX	6	.	2	28	25	.	10	83	53	90	C	P	.	11	.
30838	8304	CLE	P	MLG	.	ACR	.	9	.	1	57	.	.	86	.	.	.	N	.	.	.	.
30864	8305	ORD	P	LGT	.	ACR	.	10	.	1	81	.	.	3	.	.	.	N	P	.	.	.
30947	8308	MZJ	A	FGT	SMA	AIR	UNK	9	.	1	13	.	.	82	.	.	.	H	P	.	2	.
31032	8305	LAX	P	MLG	HVT	ACR	ACR	9	.	1	57	.	.	90	.	.	.	P	P	.	13	.
31066	8305	LGB	P	MLG	SMA	ACR	UNK	10	.	1	55	.	.	3	.	.	.	P	P	C	13	7
31106	8306	MSP	P	LGT	SMA	ACR	UNK	4	.	2	25	.	.	37	26	14	.	P	P	P	13	2
31148	8305	LAX	P	WDB	SMA	ACR	UNK	9	.	1	55	85	.	90	.	.	.	H	P	P	13	12
31219	8306	OPF	C	SMT	SMA	OGA	FED	4	.	2	25	.	.	100	44	26	25	H	C	.	7	.
31251	8306	TUL	C	SMA	.	UNK	.	11	.	4	103	.	.	27	.	.	.	P	.	.	.	.
31264	8306	ORD	P	MLG	MLG	ACR	ACR	10	5	3	81	22	.	3	46	.	.	H	P	.	13	.
31390	8307	OCA	P	MLG	.	ACR	.	4	.	2	29	.	.	3	46	.	.	P	C	.	7	.

ACN	RPTD	GIO	RPTR	ATYP1	ATYP2	OPOR1	OPOR2	TYPE1	TYPE2	INIT	EFX1	EFX2	EFX3	AFX1	AFX2	AFX3	AFX4	CONS	RINT1	RINT2	RACT1	RACT2
31459	8307	FRG	C	SMA	SMA	OGA	OGA	2	.	1	103	.	.	28	8	.	.	P	C	.	7	.
31548	8307	HFO	P	SMT	.	ATX	.	9	.	1	81	.	.	74	.	.	.	N	.	.	.	.
31569	8307	ATL	P	LGT	.	ACR	.	9	.	1	63	59	.	48	57	.	.	N	C	.	.	.
31687	8308	FRG	C	SMA	SMA	OGA	OGA	11	.	1	81	.	.	77	.	.	.	P	C	.	7	.
31738	8308	OFW	P	LGT	.	ACR	.	9	15	1	81	.	.	89	25	.	.	N	.	.	.	.
31828	8309	OTW	P	MLG	.	ACR	.	10	.	1	55	85	.	3	60	.	.	N	.	.	.	.
31887	8309	ATL	P	LGT	.	ACR	.	9	.	1	63	59	.	.	.	.	.	N	.	.	.	.
31927	8309	ORD	P	LGT	WDB	ACR	ACR	6	.	2	28	25	.	9	37	86	46	C	.	.	.	.
31927.1	8309	ORD	P	LGT	WDB	ACR	ACR	12	.	1	81	.	.	93	60	.	.	N	.	.	.	.
31969	8310	FWA	C	SMT	SMA	CPR	FBO	9	15	1	55	.	.	77	100	82	.	H	.	.	.	.
32130	8310	PB1	C	SMA	SMA	OGA	OGA	4	.	2	25	19	.	28	46	.	.	P	.	.	.	.

APPENDIX C

AGGREGATED FACTOR COMPOSITION

APPENDIX C: Aggregated Factor Composition

AGGREGATED FACTOR	CONSTITUTING FACTORS
AIRCRAFT	1. Aircraft equipment problem
	56. Pilot distraction/equipment failure
AIRPORT GEOGRAPHY	3. Airport configuration
	46. Multiple runway operation -- intersecting runways
	48. Multiple runway operation -- parallel runways
AIRPORT PROCEDURES	101. Unique airport procedures
	102. Unique airport radio procedures
AIRPORT SURFACE	4. Airport construction
	6. Airport surface condition
	14. Closed runway
	91. Runway/taxiway markings/signs
ATC COORDINATION PROBLEM	9. ATCT coordination problem
	11. ATCT/Approach coordination problem
COMMUNICATION PROBLEM	12. ATIS problem
	15. Cockpit communications problem
	30. Controller radio operation problem
	39. Frequency congestion
	45. Language problem
	51. No radio aboard
	62. Pilot failure to ascertain ATIS information
	80. Pilot misoperation of radio
	83. Pilot non-standard radio procedures
	87. Radio communication problem
	88. Radio equipment problem
	93. Similar alphanumerics
	94. Simultaneous radio transmissions
	102. Unique airport radio procedures
	106. Use of non-standard phraseology
CONTROLLER CLEARANCE PROBLEM	7. Ambiguous clearance
	8. Anticipatory clearance
	17. Complex clearance
	23. Controller failure to issue clearance but thought he had
	29. Controller misstatement of intended clearance
	33. Clearance revised
	37. Expedite clearance
	42. Hearback problem

	43. Impractical clearance restriction
	105. Untimely clearance
CONTROLLER DISTRACTION	19. Controller distraction/traffic
	20. Controller distraction/unspecified
CONTROLLER TRAFFIC SIGHTING AND VIGILANCE	25. Controller failure to visually locate traffic position
	27. Controller lack of vigilance
	104. Unknown traffic
PERSONAL RELATIONSHIPS	32. Controller/pilot relationship
	38. Facility management policy
	98. Supervisor/controller relationship
PILOT CLEARANCE PROBLEM	36. Expected clearance
	54. Pilot acting on a clearance for another aircraft
	64. Pilot failure to follow clearance
	66. Pilot failure to go around
	68. Pilot failure to question improper clearance
	70. Pilot failure to request clearance
	73. Pilot failure to verify non-standard procedure
	81. Pilot misunderstanding of clearance
PILOT DISTRACTION	56. Pilot distraction/equipment failure
	57. Pilot distraction/flying
	58. Pilot distraction/radio
	59. Pilot distraction/traffic
	60. Pilot distraction/unspecified
	61. Pilot distraction/weather
PILOT FLYING TASKS	34. Diversion to an alternate airport
	53. Non-standard traffic pattern
	57. Pilot distraction/flying
	72. Pilot failure to vacate runway
	76. Pilot inadequate preflight planning
	78. Pilot lack of inflight planning
	84. Pilot unfamiliarity with aircraft
	95. Wake turbulence avoidance
PILOT HABITS AND EXPECTATIONS	36. Expected clearance
	75. Pilot habit
WEATHER	34. Diversion to an alternate airport
	61. Pilot distraction/weather
	90. Restricted visibility
	97. Special VFR situation
	107. Weather problem

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15. Supplementary Notes

16. Abstract

This study updates ASRS's first investigation into runway transgressions, completed in 1978. Originally undertaken at the request of the FAA, the present endeavor utilizes the 1210 ASRS runway transgression reports received between May 1978 and September 1983. These incidents have been expanded to yield descriptive statistics. Additionally, a one-out-of-three subset was studied in detail for purposes of evaluating the causes, risks, and consequences behind transgression events. Occurrences are subdivided by enabling factor and flight phase designations. The study concludes that a significantly greater risk of collision is associated with controller-enabled departure transgressions over all other categories. The influence of this type is especially evident during the period following the air traffic controllers' strike of 1981. Causal analysis indicates that, coincidentally, controller-enabled departure transgressions also, show the strongest correlations between causal factors. It shows that departure errors occur more often when visibility is reduced, and when multiple takeoff runways or intersection takeoffs are employed. In general, runway transgressions attributable to both pilot and controller errors arise from three problem areas: information transfer, awareness, and spatial judgement. Enhanced awareness by controllers will probably reduce controller-enabled incidents. Increased awareness within the cockpit, as well as a mitigation of information transfer errors, are the two most pertinent focuses for minimizing transgressions that are pilot enabled.

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